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FRIDAY, NOVEMBER 16th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

ONE-HUNDRED-AND-SEVENTY-FIFTH SESSION, 1928-1929.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 19TH, at 8 p.m. (Cantor Lecture.) FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, "Biology and Refrigeration." (Lecture II.)

WEDNESDAY, NOVEMBER 21ST, at 8 p.m. (Ordinary meeting.) EDWARD PERCY STEBBING, M.A., F.L.S., Professor of Forestry, University of Edinburgh, "Forestry in Sweden: its Importance to and Influence on Great Britain." HIS EXCELLENCY THE SWEDISH MINISTER will preside.

INDIAN SECTION.

FRIDAY, NOVEMBER 9TH, 1928. SIR HUGH T. KEELING, C.S.I., in the Chair. A Paper on "Town Water Supply in India" was read by MR. J. W. MADELEY, M.A., M.Inst.C.E., M.Am.Soc.C.E., M.Inst.W.E. The Paper and discussion will be published in the *Journal* on November 23rd.

CANTOR LECTURE.

MONDAY, NOVEMBER 12TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the first of his course of three lectures on "Biology and Refrigeration."

The lectures will be published in the *Journal* during the Christmas recess.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

WEDNESDAY, NOVEMBER 7TH, 1928.

SIR GEORGE SUTTON, Bt., Chairman of the Council, in the Chair.

The Chairman delivered the following address:—

FIFTY YEARS OF BRITISH INDUSTRY.

During the last fifty years many important changes have taken place in the industrial world. The scale upon which enterprises are carried on has developed so rapidly that what was once regarded as a big business would to-day be considered quite a modest affair. Added to the growth in size of the individual undertaking, there has been an increasing tendency towards the amalgamation

of firms, or the establishment of groups within a particular industry for the promotion of common interests. On the other side we have had a parallel evolution of the trade union. Labour, like capital, has achieved its amalgamations and federations.

These and other changes have made business—using the word in its broadest sense—much more formidable and complex than it used to be. As my business experience extends over a period of nearly sixty years, I have witnessed many of the changes, and have taken an active part in some of them. I thought, therefore, that I could not better mark my appreciation of the honour done to me by the Royal Society of Arts in appointing me Chairman of their Council than by reviewing the changes which have taken place during my half century of practical experience.

No apology is needed for devoting an address to the subject of industry. Our industrial prosperity is the foundation of our existence and our security; it is the essential basis of those Arts with which this Society is directly concerned and has done so much to foster.

From Private Firm to Public Company.

Whether the Society of Arts, which even sixty years ago was an ancient body, was concerned in the legislation which has done more than anything else to change the course of industry, I do not know. I refer to the Companies Acts. These Acts performed an essential service to industry, since without the provision of shares carrying a liability restricted to their face value, it would have been impossible to obtain the capital required for the industrial growth of the nineteenth century.

The Companies Acts, however, did much more than clear the way for the free investment of capital. They opened the door wide to the enterprise of the individual, without distinction of rank, birth or privilege. Before the Acts came into full operation the characteristic type of enterprise was the family business. It was the ambition of every man who founded a business to transmit it, strong and intact, to his sons. It might also be, but often was not, the sons' ambition to strengthen their inheritance for the next generation. The stories written around this period bear witness to the strength of such family traditions. A frequent theme of tragedy was the failure of a son to do justice to his business inheritance. Industrial interests were, in short, surrounded by the same sort of feudal atmosphere as the old landed interests.

Under such conditions it was extremely difficult for anyone not possessing advantages of birth, or wealth, or influence, to rise to a responsible position in an industrial or trading enterprise. The limits of promotion for mere ability were definitely marked. Sometimes, of course, they were overstepped; often enough men of outstanding talent and great force of character would either build up a new enterprise or secure command of an existing one. But in those days the "self-made man" was enough of an exception to carry his

half derogatory title with him all through his career. What we may call the employing or controlling caste was strongly organised and well defended.

With the development of joint stock companies, especially in connection with new industries, the aristocratic tradition was transformed into a democratic tradition. I believe that to-day every avenue of advance is open to any man possessing the requisite ability, no matter what other advantages he may or may not enjoy. That, to my mind, is at once the most striking and the most encouraging feature in modern business. It affords an assurance that the supply of competent captains of industry will never fail, because of artificial barriers in the path of promising recruits.

Democratic Industry.

For a conclusive proof of the reality of this change to a genuinely democratic system one has only to look around at the men who are in responsible control of the big producing and trading firms of the present day. A very large proportion of them are men who rose from the ranks. The same principle applies to the smaller firms and also to those managers and directors who, though not having risen to the highest command—for there is not room for everyone there—still take a leading part in developing and guiding enterprise.

Modern conditions of industrial progress are at once so flexible and so rigorous that they give an unprecedented opportunity to ability, and to ability alone. Influence may provide a man with an opening, but unless he justifies himself he can never hold the position, much less advance beyond it. On the other hand, everyone in charge of a business undertaking is conscious of an insistent demand for officers with a high degree of intelligence, initiative, and strength of character. When these qualities discover themselves in any young man, whether he be on an office stool or helping at a workshop bench, they become a certain passport to promotion.

The Desire for Wealth.

The immediate motive which urges men to seek promotion is, of course, the desire to earn wealth. Just as the purpose of a progressive business is to realise more and more profit, so the ambition of each individual engaged in it is to secure for himself a large share in the results.

The instinct of acquisitiveness is indeed both fundamental and universal. Frequently one hears it decried as a rather base passion, or at best as "mere money-making." But I see no reason for regarding the impulse to become wealthy as in itself anti-social. On the contrary, it induces men to work hard, to educate themselves, to assume greater responsibilities, to confront risks with courage, and generally to make themselves more capable and progressive members of society. In the long run, no man can augment his personal wealth without increasing the service he renders to his fellow-men. The rewards of effort may be unequal, and the majority may be destined to see

their hard work gain less than is achieved by the more skilful or fortunate minority, but every rise in the standard of living and every advance in civilisation has depended to a large extent on the strength of this primitive desire to add to one's possessions.

It would be a great mistake, however, to assume that the impulse to make money is the sole or even the dominant motive in the men who have built up or gained control of large industrial or trading concerns. The deceitfulness of riches has been a favourite theme of the moralist for centuries, and his messages would have fallen on deaf ears if they had not conveyed a truth which the wealthy were able to appreciate. Money can purchase many things—comfort, beautiful surroundings, the luxury of travel, and a thousand amenities—and it can be translated into power, prestige, and other less tangible but still desirable things. But there comes a time when the man who is growing wealthy has all that money can buy, so far as his desires lead him. This stage is sometimes reached quite early in the career of a modern captain of industry. Yet again and again we find men of this class continuing their work, reaching out into new fields, and adding one wealth-producing organisation to another. Almost invariably, by what seems to the superficial observer an inexplicable irony, they continue also to lead austere and laborious lives. Rarely do they retire to enjoy what are popularly called the fruits of their labour.

Here, obviously, we are in the presence of something more than the instinct of acquisitiveness. We touch the passion of the creative artist. I am not straining a comparison when I say that the man who conceives a project and sets to work to realise it in factories and warehouses, in trained employees, and in all the other phases of a successful productive enterprise, operates very much as an artist does in painting a picture, and enjoys much the same triumph in achievement. There are many businesses to-day which did not exist thirty or forty years ago, save as an idea in the mind of one man. When the builder regards his handiwork - when he pictures the raw materials coming from all parts of the world to feed his machinery, when he thinks of the hundreds, perhaps thousands, of men and women who gain their living by operating that machinery or distributing the product would it be surprising if he feels the same sort of satisfaction as a painter or a musician who has composed a masterpiece?

"CAPTAINS OF INDUSTRY."

My personal observations and experience have led to the conclusion that it is this constructive faculty, and not a mere acquisitive instinct, which our industrial leaders work so hard to satisfy. Possession is not one thousandth part as interesting to them as creation. Life is for them as much of an adventure as it was to the Elizabethans who set sail upon uncharted seas, and finished one voyage only in order that they might begin another.

The conception of a captain of industry as a mere soulless piece of mechanism

stands in need of drastic revision. Success in this line of activity demands much more than driving force and the pursuit of efficiency. It needs, as I have explained, a high degree of imagination. It needs courage—courage to take big risks, often to stake everything on a single decision. It needs tenacity—the spirit which enables a man to keep his prearranged course in spite of reverses and even of failures. It needs the gift of judging the character and ability of others. It needs organising ability, in which not the least imporant factor is the gift of handling men sympathetically, gaining their enthusiastic co-operation. It needs all those faculties, so difficult to define, which we sum up in the word *personality*. They are at once so subtle and so powerful that every member of a world-wide organisation may in some degree or other reflect the personality of the man whose purposes they serve.

THE DISTRIBUTION OF WEALTH.

So far as the production of wealth is concerned, there has been a distinct improvement in the course of my life's experience, thanks to the expansion of the public company and the ample opportunities which that system of organisation gives to progressive and capable minds in every social grade. But when we turn to the distribution of wealth, we are confronted with problems which are far from being completely solved.

Behind many of the prevailing ideas about the proper distribution of wealth there lurks the feeling that wealth itself is anti-social. The contrast between a man who has millions at his command and another who barely earns his daily bread is so glaring that it leads to the belief that the duty of the wealthy man is to dissipate his millions.

I do not propose to argue this ancient question at length. It will be sufficient for my purpose if I point out that the proportion of the wealth which a rich man can possibly spend on himself is very small, and that what we call his wealth is really an organisation of machinery and men which renders a service to the community, and provides employment for a large number of people. We may rightly condemn a man who uses his personal wealth in ostentation and extravagance, but that is not a condemnation of wealth as such ; it is merely a verdict on the folly of an individual. It is also a reminder that the conservation of wealth, not its dissipation, is of social value. Moreover, under the joint-stock system, the capital value of enterprises which have made fortunes for their founders is shared by thousands of other people.

The problem of the proper distribution of wealth is therefore one which concerns everybody, and not simply the few very wealthy people upon whom public attention is apt to be concentrated. Reduced to its simplest terms, it resolves itself into adjusting the reward which capital should give to labour for its service.

In the early days of industry this question was settled by a process of bargaining in which, we may admit, capital had the last word. Later, when the

workers became organised, the law of supply and demand which was supposed to govern the level of wages became modified by the power of the trade unions.

One of the most notable features of the last half-century of our industrial history has been the growth of trade unions and their organisation into federations. On the employers' side there has been a corresponding growth in the number of representative associations and in their grouping for the purpose of defending their common interests and promoting the advance of industry in general. The result is that to-day we have organised labour confronting organised capital on practically equal terms. For the first time it has become possible to deal with problems of wages and conditions of labour on national lines and to discuss the broad principles upon which agreement may be reached.

FROM WAR TO PEACE.

Still more important than this development in the machinery of conference is the change in the spirit of the men who are called upon to operate the machinery. This change is quite a recent phenomenon, but I have a confident faith that it will be more than temporary.

During the greater part of my business life negotiations with the representatives of labour had very much the character of diplomatic conversations between neighbouring States with a long history of frontier wars. Where there was not open hostility there was latent hostility. Demands made by the men, or representations made by the masters, were fought out rather than argued out, and the general tendency was to resort to the strike or the lock-out at the beginning of the discussion instead of at the end. In industry, as in other fields, the will to war was very powerful and more prevalent than the will to peace.

For a long time it seemed as if there would be no escape from this atmosphere of distrust and antagonism. The more far-seeing men on both sides recognised the destructive folly of what was virtually a form of civil war, but they found it difficult to control the rebellious forces around them. Eventually, however, a beginning was made with a more rational method of adjusting differences; and through the courage and faith of men of goodwill on both sides the seed has at last been brought to harvest.

A PIONEER INDUSTRIAL COUNCIL.

I am rather proud of the fact that the industry with which I am associated was among the first to establish a successful joint council for the discussion of all questions affecting employees. This development was greatly aided by the fact that practically all the firms engaged in the industry had themselves been organised at a very early stage. The Cable Makers' Association was founded twenty-nine years ago and was thus a pioneer in what is now called the "rationalisation" of industry. I shall deal later with its chief objects and operations; for the moment I am concerned solely with the circumstance that here, as in

very few other industries, all the employers concerned could speak and act in unison. Thus they were able not only to arrange a bargain with labour, but to guarantee its faithful execution. In place of guerilla campaigns in which individual unions fought individual firms, and frequently set one against another, there was the possibility of a general conference to arrange the terms of an enduring peace.

So we came to form our "Whitley Council." The story of our enterprise is a powerful confirmation of the proverb that "it is the first step that counts." There were indeed many first steps, in the sense that time and again the old Adam would break out at one point or another of the round table and lead to an adjournment of the proceedings.

Gradually, however, the ebullitions became less and less frequent until they practically disappeared. I attribute their disappearance to a psychological factor which, although of the simplest character, is of the most vital importance and provides the key to success in all such efforts at joint action. The peace which ensued was not the peace of exhaustion but the peace of understanding. Meeting as we did again and again at the council table, we got to know each other intimately and to realise that with all our faults and our differences of opinion we had a common denominator of decent humanity, and were alike endeavouring to do our duty by those we represented. Personal contact proved a slow but efficient solvent of distrust.

This experience is a useful reminder of the truth that machinery is less important than the spirit in which it is operated. We may devise the most perfect system of conciliation and arbitration, but it will be useless if the people concerned are not inspired by goodwill and mutual understanding. That explains in some measure why the spontaneous and more or less informal conference initiated by Lord Melchett has succeeded where official efforts have met with resistance. The personal factor has been allowed full freedom of action. Questions have been handled as man to man and not between delegates acting under rigid instructions.

The Personal Tou

Personal contact is absolutely essential to a proper understanding of other people's point of view. Our repeated discussions with the representatives of trade unions gave us an insight into the ideals and difficulties of labour, while they in turn came to realise the limitations of manufacturers who had to maintain production on a profitable basis under the severest competition.

Without open and frank discussion it would have been difficult for the representatives of labour to appreciate the fact that an employer is after all a trustee for the interests of his shareholders and his customers. Without mutual knowledge it would have been difficult for the clear conviction of the common interests of employer and employed in the prosperity of their industry to emerge from the dust of perpetual conflict over wages and hours of labour.

Wages Difficulties.

Thanks to these changes, we are now able to discuss questions of wages in the spirit of partnership. It is in that spirit I wish to offer a few observations on one or two outstanding difficulties.

The prevailing rates of wages are fixed partly by custom and partly by arrangements made with the trade unions concerned. Trade union policy aims at uniformity ; it is satisfied if the standard rate of wages is accepted by all employers and paid to all workmen, irrespective of the personal merit of the worker or the prosperity or otherwise of any particular factory or group of factories. The object of this policy is the meritorious one of securing to every worker a living wage and if possible something more. Yet it must be admitted that the standard wage system imposes an artificial uniformity in a field where there is a great natural diversity.

From the point of view of the individual worker, it means that no matter how skilful he may be or how hard he may work, he cannot advance beyond the standard rate of wages.

From the point of view of the individual factory or industry, it means that no matter how hard-pressed it may be, it cannot meet the situation by reducing wages, and no matter how prosperous it may be, it cannot pay more than the standard rate.

Let me give an illustration. Many different industries—engineering shops of various kinds, shipyards, and my industry of cable making—employ the highly-skilled men known as fitters. Shipbuilding and some branches of engineering are, for reasons largely outside their control, in a depressed state. On the other hand, cable-making, on account of the ever-increasing development of electricity, is prosperous. Within that industry itself there are degrees of prosperity. If the level of wages were regulated by the prosperity of each separate undertaking, the workers in the less prosperous concerns might feel a sense of injustice which would introduce a distinct element of discord.

Anomalies in Wages.

There are other anomalies which the joint councils of our various industries would do well to attack. One is the disparity of wages in sheltered and unsheltered trades. Is it right that skilled workers should be paid no more, and sometimes less, than workers in unskilled trades ? This anomaly has arisen simply because the sheltered trades have been able to raise the cost of their service to the public and consequently pay their employees more than the natural relative value of their work. While it endures, it has a tendency to attract into lower-grade occupations men who would be capable of giving better service and employing their faculties more fully and more happily in skilled work.

The ultimate object of trade union activity is to secure to labour a larger share in the results of industry. To-day, much more than in earlier times, it is

realised by the representatives of Labour that this is a very complicated problem not capable of complete solution merely by incessant action to force up the general level of wages.

PIECEWORK.

When this problem is considered, most people's thoughts turn to piecework and profit-sharing. Piecework, however, is applicable only to certain types of labour and it is not regarded with much favour by the trade unions. Their objection to it is partly a general dislike of all departures from standard rates of pay and partly a distrust born of experience. Cases have occurred where piecework terms have been modified by the employer because a proportion of workers have regularly earned more than was considered appropriate to the grade of labour. Where such modifications have been enforced they have engendered a very unfortunate—and I think quite natural—sense of hostility and distrust, but we may hope that in the better spirit of mutual confidence which prevails to-day it will become possible to extend the piecework system on a basis satisfactory to both parties.

PROFIT SHARING.

In some quarters profit-sharing is regarded as a complete solution of the problem. Opinion is, however, still divided as to its merits, or rather the extent to which it can be usefully applied. The underlying principle is sound enough, as it gives the workers a share in any advance beyond a standard measure of prosperity. Where an industry is of a comparatively steady character, as in the case of a public utility or of a company supplying a commodity in regular demand, it affords a convenient method of securing a periodical bonus to the staff. But difficulties arise when fluctuations occur from profit to loss, and as a general rule the workers are more attracted by the prospect of a higher weekly wage than of lump sums at widely-separated periods.

So far as manufacturing industries are concerned it is, I think, better to aim at a system which secures to each grade of worker the highest possible wage, rather than to attempt to apply a rigid profit-sharing system to a constantly changing set of conditions. There are, I admit, cases where profit-sharing has been successfully applied and is firmly established. On the other hand, there are cases where it has not proved popular. The inference which may fairly be drawn, is that a very careful survey of each case should be made before the hope is entertained of making all grades of workers contented by means of profit-sharing.

CO-PARTNERSHIP.

Co-partnership is a somewhat different proposition, as it aims at enabling the workers gradually to acquire a proprietary interest in the concern from which they draw wages.

Here again it is difficult to discover a solution applicable to the general run of industrial concerns. The only type of company in which a worker should be encouraged to invest his savings is one of a steadily prosperous character. These are precisely the cases where the price of the shares advances far beyond the nominal value and gives the purchaser a yield not much greater than on a gilt-edged stock. If, therefore, the worker buys the shares at the market price he secures only a modest return; and if, on the other hand, the company allows its employees to acquire shares at par, it must consider that it is presenting them with a substantial bonus at the expense of the other shareholders.

The difficulty which is here indicated is not confined to problems of co-partnership. It affects the development of industrial enterprise in general. When a company has become fairly prosperous, the rise in its share level gives the original shareholders an opportunity, which they generally seize sooner or later, of realising at a substantial profit. The new shareholders buy their shares at such a price that unless the Company maintains its dividend the yield becomes unsatisfactory. Thus we reach the curious state of affairs in which a Company struggles hard to keep up a 15 or 20 per cent. dividend on its ordinary shares while the general body of shareholders actually realise nothing more than 5 or 6 per cent.

The Reward of Labour

Returning to the broad question of the distribution of wealth, there is an important point upon which a great deal of controversy has turned.

We hear it argued by idealists that the reward of labour should come before that of the employer. However attractive this may be in theory, it can hardly be said to provide a sound working principle. The mainspring of enterprise is the desire to earn a profit, but if the claims of labour are to take precedence of this primary factor it is inevitable that enterprise will be discouraged. Labour will gain much more in the long run by encouraging initiative than by imposing upon all industrial adventures the duty of meeting, before all else, whatever claims the rank and file may choose to make upon those who are risking their money and their professional reputation.

Similarly in the case of an established undertaking. The capacity to earn a profit is the fundamental condition both of survival and of progress. Everything must be made subservient to the need of reaching the profit-earning stage. As the recent remarkable agreement between the railway companies and the railwaymen's unions clearly shows, the truth of this contention has come home to the workers. They have agreed to an all-round reduction of $2\frac{1}{2}$ per cent. in wages because they realise the necessity of restoring the railways to the profit-earning level. Without that restoration, their hopes of regular and well-paid employment must gradually disappear.

The more this matter of profit-earning is considered, the more definite

becomes the conviction that labour has everything to gain and nothing to lose by encouraging the making of substantial profits. In most industrial undertakings employing large bodies of labour, the workers would stand to gain nothing appreciable if dividends were distributed among the employees instead of the shareholders. Interest on capital is usually a very small fraction of the total wages bill. But when dividends are substantial, the workers stand to gain in various directions. Steady, well-paid work is assured them; the company enjoys the security and resources which enable it to extend its salesmanship and obtain new orders; and the dividends make it easy to secure capital for extensions, for renovations, for replacement of old with more efficient plant, for research, and for other developments which improve and widen the market for labour.

In short, profit for the shareholder means progress and prosperity for all concerned—labour not least of all. Viewed in this light, the once prevalent notion that profit was something taken from the worker and given to the people who had no just claim upon it, is seen to be false. From the ambition which human nature entertains—selfishly if you like—comes enterprise, and from enterprise conducted on a profitable basis comes the ability of a community to maintain an increasing population in comfort and amenity.

THE SOCIAL VALUE OF PROFIT.

It is necessary to emphasise the social value of profit because the contrary view is likely to hamper an industrial development of a most important and useful character.

I have already referred to the tendency of firms engaged in the same industry unite for mutual benefit. This is a comparatively recent phase of industrial olution. Fifty years ago the individualist principle was supreme. Every firm prided itself upon its independence and accepted the law of unfettered competition as not only a natural but an absolutely beneficial dispensation. Public opinion was dead against any measures whatsoever for modifying the rigour of rivalry, whether at home or abroad.

A different spirit prevails to-day, and its growth is one of the most significant of the changes I have witnessed.

The causes of the change are not obscure. An industrial policy of laissez-faire was appropriate enough when Britain enjoyed a practical monopoly in most fields of engineering and kindred enterprise. The world was ours, and it was so wide that individual firms found plenty of elbow room for the exploitation of an ever-increasing demand. But when the Continent and the United States of America began to build up productive organisations of their own, British firms found one market after another being closed to them. They also found themselves competing, not with individual firms, but with industries organised within themselves and in conjunction with banks and even with Governments, so that a formidable combination of State influence, powerful finance houses, and

co-operating producers was encountered in overseas markets and even in our own home market.

Some time elapsed before the alteration in the conditions was fully realised and steps taken to meet it. The traditions of independence are slow in dying, and it was difficult for firms which had always pursued their own course and treated competitors as their natural enemies to reconcile themselves to the limitations and sacrifices involved in common action. Even to-day there are many industrial groups where the members chafe under the chains of co-operation, and threaten at frequent intervals to break them. The only thing that restrains them is a recollection of their much less fortunate condition when anarchy prevailed.

THE STORY OF THE C.M.A.

I have already mentioned that the Cable Makers' Association was one of the first bodies of its kind to be formed. It will be interesting, I think, to review its history in order to indicate the reasons for the formation of the Association and to outline its activities and its results.

Fifty years ago the electric lamp was born, and in turn gave birth to a new industry—the generation and distribution of electricity to the public. Previous to that event, the telegraph, both land and submarine, was the main item in electrical engineering, and when the demand arose for insulated cables suitable for electric lighting, it was natural that the firms engaged on telegraph cable production should endeavour to meet it.

Many new problems, some chemical, some physical, some electrical, some manufacturing, had to be solved. The carrying of heavy currents at high pressures was in many respects a more formidable problem than that of transmitting the light currents used in telegraphy. The public safety was involved in the solution of these problems; so also was the prosperity of the new industry, since reliability, efficiency, and long life in cables were essential to satisfactory service.

At an early stage in the cable-making industry, the firms became acutely conscious of these problems and also of the opposition between the need for a high standard of quality and the desire for cheapness. They also realised that there was nothing to distinguish, in the sight of the ordinary buyer, a high-grade cable from a low-grade one. There was an obvious danger that unregulated competition would make price the sole consideration in cable contracts and would thus bring about a steady deterioration in the quality of the all-important link between the power station and the public, and of the wires which the user of electric light installed on his premises.

In order to avert this danger the leading firms came together twenty-nine years ago and formed an Association primarily for the purpose of fixing and adopting standards of dimensions and quality in electric cables. To-day these standards are recognised all over the world. It is largely to them that we owe

the exceptional reliability of electric supply in this country and the high degree of safety which attends the use of electricity in our homes and in buildings of all kinds. It is perhaps worth recalling that during the War many of our networks of electric mains were heavily overloaded owing to the successive additions of munition factories. The strain put upon them for months, and in some cases years, was far greater than anything regarded as possible, to say nothing of permissible, when they were designed and manufactured. Nevertheless, the margin of safety provided by high quality insulation, and ample dimensions, enabled them to carry their tremendous overloads with only an occasional interruption.

REGULATING COMPETITION.

The co-operative action of the Cable Makers' Association did not, however, end with standardisation. It extended to the field of competition.

At that time it was a very rare and a very suspect thing for firms in the same line of business to agree not to engage in an orgy of cutting prices or not to work ruthlessly towards the extinction of competitors. The Cable Makers' Association proceeded on the assumption that the field was large enough for the growing prosperity of all of them and that their individual as well as their common interests and those of electrical enterprise as a whole would be best served by keeping competition within reasonable bounds.

This view was not, as you can well imagine, shared spontaneously by the public or by the buyers of cables. The Association was regarded as a "ring" and incontinently denounced as such. Protests were continually being made against the maintenance of prices, and in some quarters the break-up of the Association would have been welcomed as an unmixed boon.

Many attempts were made to achieve this destruction. They were made by firms in this country; they were made, on a much more formidable scale, by firms abroad. But the Association was able to resist all these attacks, and its survival is a conclusive proof that the members were able to render better service than their opponents. Users of cable might denounce "rings" in more or less emphatic language, but they appreciated the vital importance of quality in cables and they realised the value of the guarantees which the Association was able to give with the full weight of organised firms of the highest repute.

Moreover, the security which combined action gave to the firms concerned enabled them to keep abreast of, and indeed ahead of, the needs of a rapidly expanding and changing industry. As the electric light undertakings developed into power supply undertakings, new technical and manufacturing problems arose, demanding for their solution a great deal of costly research and experiment. It would have been impossible for the industry to undertake this development work if it had not enjoyed the security and the financial resources which a measure of combination afforded. As things were, it was able to increase its output continually and to keep always in the vanguard of technical

progress and manufacturing efficiency by a judicious use of the strength which organised prosperity gave to it.

The C.M.A. rightly claims that it has "demonstrated that it is possible for a number of firms, entirely independent of one another financially, and, broadly speaking, working competitively, to concentrate the competition on being one of quality and effective service to the customer, rather than on to a ruinous price competition. The effect of the economies arising from concerted action in the directions which have been indicated has been such that the actual prices are so low relatively to the quality dealt in, that it has been almost impossible for newcomers to the industry to offer equally high qualities at lower prices."

One need not be surprised therefore, that the Cable Makers' Association has been adopted as a model for later groups of manufacturers and has done a great deal to allay the public suspicion with which every form of industrial combination was once regarded.

The Value of Amalgamation.

The principle of industrial combination is now as firmly established as the principle of amalgamation which came into force about the same period. It may be said that it is more firmly established, since the advantages of combination increase with every application of the principle, while in the case of amalgamation there are strict limits to the benefits which can be realised.

The object of amalgamation is to secure greater economy in production, management and salesmanship, greater financial stability, and a firmer hold over raw materials and the conditions of sale for the final products. Where firms are engaged on precisely the same form of production, or where they contribute their several manufactures to cover a particular industry—such as electrical engineering, or chemicals—amalgamation will secure its object if judiciously carried out on sound financial lines.

There have been, however, cases of amalgamation where firms have absorbed others with which they had no organic relation. The result has been that a medley of problems of production and salesmanship had to be solved by a board without cohesion, without the capacity or the opportunity to frame a common policy. Amalgamations of this kind are simply an overcapitalised anarchy, and their inevitable future is a drastic process of restoring the several parts to independent ownership and writing down the capital to something approaching the true value of the assets.

War conditions encouraged a great deal of this reckless union of incompatibles. Amalgamation was held to be a prime element in the reconstruction which was needed to prepare British industry for the after-war of international commerce; and in the rather fevered temper of the times the limitations of even an uncontroverted policy were not always recognised. We understand better to-day that an amalgamation may be weaker than its component parts, and that great

skill in selection is needed to secure the genuine unity which alone means strength.

Peace in Industry.

We now live in an era of Big Business. The tendency of the time is to concentrate the power of control over production by mergers or amalgamations in one form or another. At the same time, where manufacturers remain independent, there is a complementary movement towards unity by the formation of industrial and trade associations.

Both movements will, I am sure, tend to greater prosperity for everybody engaged in industry and to better service to the community. They will also, as I have already indicated, smooth the path of industrial peace by enabling decisions about the conditions of labour to be reached by a small but fully representative conference and given effect over the greater part of the industrial field.

While on this point I would like to suggest an effect which the higher organisation of industry will have upon the cause of industrial peace. So far as our own country is concerned, efforts are being made to modify competition by co-operation, and it appears that steps have been taken in some industries to make treaties with the organised industries of other countries. If this movement continues, the nations will in time be bound together by a series of industrial agreements in which their interests are closely involved. This network should prove a powerful reinforcement for the foundations of international peace.

Research.

The better organisation of industry, both by amalgamation and the formation of associations, has a direct bearing upon the important subject of Research. It used to be a common subject of reproach against our manufacturers that they neglected research. A generation ago there may have been plenty of ground for the reproach; to-day it is only in exceptional cases that it can be justly applied. And the change is largely due to the transformation from independent competing firms to co-operating organisations.

Industrial research on the modern scale is a very costly and speculative undertaking. It needs large laboratories, equipped with expensive plant and manned by highly skilled experts in various branches of science. Its purpose is to adventure across the frontier between knowledge and ignorance and reach out over the unknown in the hope of discovering a treasure. However skilfully conducted, missions of this sort may only too readily end in nothing.

Clearly no industrial firm can embark on an organised research policy without possessing security, stability and surplus profits. When our industrial picture revealed a number of small and exclusive companies fighting each other gallantly for every order that came along, cutting prices in a desperate effort to maintain

output in the face of both home and foreign competition, and experiencing rapid fluctuations of good and bad fortune, there was no place where research could have been introduced. The utmost that could be attempted was the equipment of a works laboratory for the testing of materials and for occasional experiments on new inventions. To spend thousands of pounds on a research department and install in it a physicist, a chemist, a metallurgist and other specialists in the hope that they might eventually achieve some beneficent revolution, was altogether Utopian.

With the growth of organisation, however, the whole situation changes. A large amalgamation or an industrial association can afford to face the cost and accept the chances of research on elaborate lines. The research laboratories to which our attention is so often drawn on the Continent and in the United States are all associated with the largest and most prosperous Trusts. The further we carry our industrial organisation either by amalgamation or combination, the more capable we shall become of bearing the luxury—a very profitable one at times—of reasearch.

Let me again draw an example from my own experience. Some years ago the cable-making industry realised that it enjoyed a rather imperfect knowledge of what actually happened to its cables when laid underground. Dimensions and materials had been determined on empirical lines and they were known to be satisfactory in a general way. But no one knew with scientific precision whether the standard sizes of cable were capable of rendering a higher service than that for which they were specified.

The problem was one which concerned every cablemaker; or rather, it concerned the user of cables more than the manufacturer. A committee was appointed by the Electrical Research Association to investigate the subject of the heating of buried cables, and through the existence of the organisation of the leading cable makers, this joint experience was available for the use of the committee, and the result of this co-operation was that the Electric Supply Authorities were assured that they could effect material economies in their transmission systems.

A further development of joint research is now under way. Each member of the Cable Makers' Association has been engaged upon independent research for a number of years. Their enterprise in this direction is part of the healthy rivalry which is maintained within the circle of the Association. But it is inevitable that several of the cable research laboratories must be engaged simultaneously upon the same problem—as, for example, the behaviour of insulating materials at the extra high pressures now adopted on mains transmitting large quantities of electricity over long distances. Duplication of this kind tends to waste of effort, and arrangements have recently been made for co-ordinating the material and mental resources of many cable research laboratories on the main problems awaiting solution.

In enterprise of this description the British manufacturer finds invaluable aid

in the National Physical Laboratory and the Department of Scientific and Industrial Research. Of late years the State has, through these organisations, so efficiently seconded the research work of large industrial firms and associations that we may rest assured that the help which science can render to industry is being adequately exploited.

EDUCATION.

Now I come to an aspect of my subject upon which, though it is of great importance, I can do no more than briefly touch. I refer to education, in connection with which this Society has played a most distinguished and useful part.

The fact that the Royal Society of Arts has held this year, examinations, for which there were over 100,000 entries, is proof of a wide-spread desire for education among recruits in the army of commerce. All these candidates desire to excel in some special branch of knowledge. This desire is the only thing that really counts. I feel it would be a waste of public funds to try to force young people to acquire knowledge and proficiency if they have no genuine desire for the acquisition. Attempts in that direction have been made in recent years, but they have failed in their purpose. Young people should certainly be encouraged and helped to make themselves more proficient for the battle of life, but a voluntary impulse on their part is essential to success.

If we are to make the best of the material which the school provides for the manning of our industrial army, we must enlarge the opportunities for education until they are open to all. The ideal educational system is one which provides a clear course from the elementary school through the secondary school to the University, for those who have the character to avail themselves of it. Educational progress is already tending in this direction, and I think the advance would be accelerated by the provision of scholarships by the State. Some assistance of this kind is essential if equal chances are to be enjoyed by all grades.

Of late years there has been an increasing desire to employ public school boys in industry. Their training fits them admirably in many ways for positions of control, but they labour under the disability that they enter the workshops or offices at a comparatively late age. The lad who goes direct from the ordinary school into employment has gained five or six years practical experience, and has therefore become definitely useful to the employer, by the time the public school boy comes on the scene.

What the employer wants is, of course, a combination of higher education and practical experience. Under present conditions this combination is generally impracticable and a choice must be made of one or the other. Whether it is possible, by some revision of our system of training, to secure a measure of both qualities in the young men who are fitting themselves for responsible positions, is a problem which our educational authorities should seriously consider.

In this connection I do not overlook the excellent results which have been achieved in technical training when a really great teacher gets around him a body of students attracted by the tradition of his teaching. I have in mind two outstanding examples in the Electrical world, one the old Finsbury Technical College under Professor Ayrton, and the other the Faraday Training Institution under Professor Harrison and Dr. Alexander Russell.

In this review of a half-century of industry I have touched upon some of the principal changes and dealt with important problems which have been solved or still await solution. Surveying this period of our industrial history as a whole, I think it reveals a great deal of solid and enduring achievement, and encourages the confident belief that, if we make intelligent use of our resources, and above all of our human resources, the future will witness a continuous advance in the general welfare.

The Chairman then presented the Society's silver medals for Papers and Lectures delivered during the last session as follows :—

Papers read at the Ordinary Meetings :—

S. J. Duly, M.A., Head of Department of Commercial Products, City of London College, Mitchell Student for 1925-6, " The Damage to Cargo due to ' Ship's Sweat.' "

Major R. G. H. Clements, M.C., M.Inst.C.E., " The Evolution of Modern Road Surfaces."

Charles Herbert Wright, B.A., " Modern Aspects of Rubber Cultivation."

Alfred C. Bossom, F.R.I.B.A., " American Architecture."

William Taylor (of Messrs. Taylor, Taylor and Hobson, Ltd.), " Standardisation in Apparatus for Science Teaching."

Captain Reginald Willington Lane, " The Sterilisation of Milk."

Papers read before the Indian Section :—

M. M. S. Gubbay, C.S.I., C.I.E., " Indigenous Indian Banking."

Sir David T. Chadwick, C.S.I., C.I.E., " The Indian Tariff Board."

S. C. Stuart-Williams, M.A., Chairman of the Commissioners of the Port of Calcutta, " The Port of Calcutta and its Post-War Development."

Papers read before the Dominions and Colonies Section :—

His Excellency the Marquis de Merry del Val, G.C.V.O., LL.D., Spanish Ambassador, " The Djebala and Rifi Country of Morocco " (with cinematograph illustrations).

Sir Stephen Montagu Burrows, C.I.E., " The Ancient Civilisation of Ceylon."

Trueman Wood Lecture :—

Sir James H. Jeans, M.A., D.Sc., LL.D., F.R.S., " The Wider Aspects of Cosmogony."

Sir George Birdwood Memorial Lecture :—

Sir Edward A. Gait, K.C.S.I., C.I.E., " Ancient Bihar and Orissa."

Mr. Alan A. Campbell Swinton, F.R.S., in proposing a hearty vote of thanks to Sir George Sutton, said that all present would agree that the address which they had just heard from Sir George Sutton was of a very remarkable character. It had been his (the speaker's) good fortune to have had personal relations with a number of Captains of Industry. He had begun in the year 1881 by being apprenticed to the first Lord Armstrong, who had undoubtedly been a great Captain of Industry. Later he had come under the aegis of Sir Andrew Noble, who had followed Lord Armstrong in the business of Messrs. Armstrong, Whitworth until his death. He was also personally acquainted with another Captain of Industry, Sir Charles Parsons. Nevertheless, he thought that he could say truthfully that not one of those gentlemen could have given as good a lecture upon Industry as Sir George Sutton had delivered that evening.

As a rule the qualities which made a man successful in business were not the same as those which made him a good writer or speaker. Certainly his own experience was that some of those with whom he had had to do, who undoubtedly were very great men in the industrial world, were the worst speakers he had ever come across; but those present that evening had had a really remarkable exposition of a very complicated subject, which showed that Sir George Sutton had given a great deal of thought, not only to the work to which he had devoted his life—which was the Cable Industry—but to Industry in general, and that he had a very comprehensive grasp of the whole subject—a more comprehensive grasp than most people, certainly politicians, possessed. He thought that the Royal Society of Arts was very fortunate in having for its Chairman a gentleman who had such wide experience and knowledge, and who was able to impart it in such a very interesting way.

Sir Edward Gait, K.C.S.I., C.I.E., in seconding the vote of thanks, said he was sure that everyone present could not but feel the highest admiration for the thoughtful, comprehensive and most illuminating address which Sir George Sutton had given.

The vote of thanks was carried unanimously.

The Chairman, in acknowledging the vote, said he had been afraid that his address might be boring to his audience, but there had been nothing else upon which he could have addressed them. He believed his position on the Council of the Royal Society of Arts was due to his contact with the commercial life of this country. There were all sorts of very eminent people on the Council, and he confessed that he had felt a little frightened to come before them and give an address upon commerce. However, he had got through it, and he thanked the audience for the patience with which they had listened to him.

NOTES ON BOOKS.

A Short History of Medicine; Introducing Medical Principles to Students and Non-medical Readers. By Charles Singer. Oxford: at the Clarendon Press. *7s. 6d.* net.

Dr. Charles Singer, who is of Oxford as regards primary standing or graduation, now does good service in the University of London as "Lecturer on the History of Medicine." The author's "Studies in the History and Methods of Science," a gathering from many sources, with himself as editor and unifying factor, has led

him to his recent booklet on Greek Biology and Greek Medicine ; also to the work under notice.

Thoroughness and accuracy are combined with that lucidity which results from an orderly habit of thought, and care in the selection of words ; hence the book is well suited for the popular library and ordinary reader, but the veteran medical practitioner may be just the one to find full joy in adding it to his library. Its total of pages is XXIV + 368, and abundant illustration is a feature—143 illustrations all told, many being whole-page reproductions. All illustrations are so strictly germane to the text as to strike the reader at once in a first general view of the work, and often exemplify Dr. Singer's characteristic manner of blending ancient with modern history. Opposite p. 46 we have a whole-page reproduction showing the ruins of an ancient Roman aqueduct. This illustrates the account of Roman sanitarians, as strengthened by that Julian edict which " conferred citizenship on all who practised medicine at Rome, in order to induce physicians to settle " (p. 46). Vitruvius, who was technical adviser to Julius Cæsar, treats at length of water supply in Book VIII of his *De Architecturâ*, and he upholds the open aqueducts as against transmission by pipes, especially leaden pipes. The Roman military dressing-station (from Trajan's column) shown by Fig. 17, contrasts with Fig. 128, in which Florence Nightingale is shown as receiving wounded at Scutari ; a similar contrast being found by comparing Fig. 112, an operation in the sixteenth century, with Fig. 113, where we see work under those antiseptic conditions embodied in the general term Listerism. The growth of antiseptic surgery runs through the book ; Figs. 106 and 107 leading the mind to the conclusive theoretical position established by Pasteur. Abundant illustrations are given of microbial organisms as bearing on practical Listerism, and on the various infective disorders, largely or mostly febrile, now known to be of microbial origin.

Fig. 119, on p. 263, is in no sense pictorial ; it being a chart or graph showing the notable and almost unbroken diminution in mortality by laryngeal diphtheria during a period of seventeen years, the test area being one in which antitoxin serum was used. In the section (headed " The Study of Immunity "), including the above-mentioned chart or graph, we find an account of the ways in which dead products of microbial action can give protection, either partial or complete. So widespread is the use of such toxins or serums that one may now have a puppy inoculated against distemper.

Mechanical appliances as used by the practitioners of old times are figured in many places, but we may mention the " bob," or " momentum," drill figured on p. 64, and shown in use by the seventh-century reproduction, Fig. 22 on p. 63 ; also we turn to Fig. 9, which shows us a sixteenth century trephine made in accordance with descriptions or inspirations from ancient Greek sources, and to Fig. 15, where a group of first-century surgical instruments, found at Pompeii, is delineated. The special interest of these relics of Rome is that they are actual possessions, showing not only the design but the workmanship, the mechanical dilator with screw adjustment and two-part speculum being of very notable interest.

The final illustration, " Friendly Death," is opposite p. 362, and bears on Dr. Singer's epilogue ; the picture shows us a belfry in which the conventional figure of Death is tolling the passing bell, but with head slightly bowed and face turned away from the open eastern arch, through which the first gleams of dawn are shining. These morning gleams faintly illuminate the face of the old man, who is almost smilingly passing through the *Janua Vitae*, and in the text opposite we read the author's teaching as to the true function of medical science. This must be read to be understood, but a note running through the whole is that the intelligent practice of medicine " should enable us all to live out our full lives."

Although, in the main, a record of triumphant progress and joy, a faint strain of threnody may be traced in many parts of the Epilogue, pp. 352-362. Dr. Singer tells us of the "unreadable bulk" of scientific literature (p.353), and deals with the growth of modern Determinism ; then he goes back three centuries to Descartes, against whose oft-quoted basic doctrine a "newer school" is showing itself ; a school that seems to attack or deny mentalism and to exalt materialism, p. 356. Here the author feels himself in the presence of a dilemma, which he cannot cast off at the moment ; but he goes so far as to say that "determinist thought, which lies at the basis of modern medical developments, has not been so universally successful as is often supposed." The tendency has been to separate those strains of knowledge (end of p. 353 ; also of p. 356) which give the full aspect of things when taken together. As an outcome we have the view that "the Humanities and the Sciences are far from being as independent of each other as many suppose" ; that "the growing interest in science has had an unfavourable effect on education," and that "many scientific publications are but semi-literate."

Here, indeed, is a book which all classes may read with advantage, and the epilogue should be specially studied by our administrative and educational officials.

THE CHEMISTRY OF CRUDE DRUGS. By John Edmund Driver, M.Sc., Ph.D., A.I.C., Lecturer in Chemistry, University College, Nottingham ; and George Edward Trease, Ph.C., Lecturer in Pharmacognosy, University College, Nottingham. London : Longmans, Green & Co., Ltd. 10*s.* 6*d.* net.

The term "crude drugs" is generally used to denote simple tinctures, extracts, etc., derived directly from such natural products as roots, leaves and seeds. In this form the preparations necessarily consist of mixtures of a number of substances ; but for many purposes pure compounds are not needed, and these mixtures therefore find a very wide application in pharmacy.

While the more important examples are familiar enough, in respect of name, origin and physiological properties, to pharmaceutical students, the authors have rightly considered that there exists an unnecessary hiatus between the teaching of materia medica and that of organic chemistry. The function of the present text-book is to bridge this gap, and it may be said to do so in an admirable manner ; in fact it should prove not merely useful to the pharmacist, but also extremely interesting to the student of organic chemistry, who is accustomed to finding a certain dullness in pharmaceutical works.

The classification and treatment throughout are chemical instead of morphological, and structural formulæ are usually given. It may perhaps be open to doubt whether the average pharmaceutical student will take a very intelligent interest in the structural formulæ of even such a comparatively simple molecule as that of (say) borneol, if he is ignorant of the long history of the determination of that structure ; but even he will obtain considerably more benefit from the full picture than from such a representation as $C_{10}H_{18}O$.

An excellent feature of the book is the compilation of classified tables collecting together much useful information as to the origin of groups of drugs, and also as to their principal constituents. It has been the policy of the authors to avoid over-burdening the book with references to original papers, but much recent work has nevertheless been incorporated, as may be seen by referring to such subjects as the constitution of muskone, or the characteristics and determination of the vitamins.

COMMERCIAL ART PRACTICE. By Charles Knights and F. E. Norman. London : Crosby Lockwood and Son. 15*s.*

The posters of Mr. McKnight Kauffer have proved that the words "Commercial Art" are not necessarily contradictory. Before they had done so, Mr. Roger

Fry had written that perhaps advertising might evoke originality in someone. Of ingenuity, at any rate, it has been most productive, and though we are less attracted than distracted by contemporary hoardings we must admit that here and there interesting work is to be seen.

In the United States there are, I am told, some six hundred thousand folk connected with advertising. The number in the United Kingdom must also be impressive. Commercial artists abound; the young man or woman who intends to enter the field and compete with them will find many useful hints in this book by Messrs. Knights and Norman.

They have a certain amount to say about psychology. What, as a matter of fact, is the last word about the reactions of the public to the counter-claims of the poster? What is the megalomaniac to do who is informed that the "Majestic" is the largest vessel afloat, whereas the "Leviathan" is the biggest steamer in the world? One understands that the soap-merchant who can afford to advertise sells more soap than the one who cannot; but if there are two equally fast and efficient trains to John-o'-Groats, and we have no alternative but to go by one of them, what is the point of either of them being boosted?

The practical side of "Commercial Art Practice" is excellent. The authors explain the various reproductive processes most thoroughly, and illustrate them in such a way that no one could fail to understand them. Blocks, tints, type-faces are all dealt with; then there are chapters about design and layout; finally the domestic economy of free-lancing receives attention. I wonder whether the authors chose the type in which they have here been printed. The ligature does not quite seem in keeping with such a robust subject.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 19..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Sir Arthur J. Evans, "The Palace of Knossos in the Light of Recent Reconstitutions."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Chemistry—Modern Pigments: their Proper Selection and Use."

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Schweich Lecture I.)

Electrical Engineers, Institution of, at the University of Liverpool. 7 p.m. Prof. G. E. Scholes, "Combustion."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Miss G. Caton-Thompson and Miss E. W. Gardner, "Recent Work on the Problem of Lake Moeris."

Imperial Institute (Cinema Theatre), South Kensington, S.W. 10.15 a.m., 11.35 a.m., 2.15 p.m. and 3.35 p.m. "India."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. G. R. Bamber, "Automatic Combustion Control of Furnaces."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (1829-1928)." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. Ifor L. Evans, "Economic Problems of the Danubian Area."

At King's College, Strand, W.C. 5.30 p.m. Rev. Dr. R. S. Franks, "Protestant Scholasticism."

At the London School of Economics, Houghton Street W.C. 5 p.m. Don S. de Madariaga, "Disarmament." (Lecture III.)

At University College, Gower Street, W.C. 5 p.m. Professor E. B. Verney, "Urinary Secretion." (Lecture VI.)

5.30 p.m. Dr. Paul Stamberger, "Colloid Chemistry and its Relation to the Rubber Industry." (Lecture IV.)

TUESDAY, NOVEMBER 20..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. A. Leslie Armstrong, "Report on Excavations in the Tin Hole Cave, Cresswell, and the recent Discovery of an Engraving of a Masked Human Figure."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Chemistry—Methods of Wall Painting."

Automobile Engineers, Institution of, at the Engineering Club, Wolverhampton. 7.30 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Prof. W. E. Dalby, "Mechanical Properties of British Rail-Steels."

Heating and Ventilating Engineers, at Milton Hall, Manchester. 7 p.m. Mr. W. Gregg, "Fabric Drying."

Imperial Institute (Cinema Theatre), South Kensington, S.W. 10.15 a.m., 11.35 a.m., 2.15 p.m., 3.35 p.m. "India."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 7.30 p.m. Mme. G. M. Vassal, "Through Tonking and Yunnan."

Royal Institution of, 21, Albemarle St., W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture I.)

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Mr. A. W. Flux, Presidential Address, "The National Income."

University of London, at King's College, Strand, W.C. 5.30 p.m. Miss Hilda D. Oakeley, "Aristotle's Idea of Deity."

5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VII.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. H. Clifford Smith, "The Furniture and Equipment of the Home."

6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture II.)

At Westfield College, Hampstead, N.W. 5.15 p.m.

Sir Charles Grant Robertson, "The Map of Europe." (Lecture II.)

WEDNESDAY, NOVEMBER 21..Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Chemistry—Recent Researches on the Preservation of Ancient Buildings and Stone Decay."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testament in Muslim Religious Art." (Schweich Lecture II.)

Chadwick Public Lecture, at 11, Chandos Street, Cavendish Square, W. 5.15 p.m. Dr. E. P. Cumberbatch, "Physio-Therapy, with special reference to Medical Electricity."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Address by Mr. H. G. Cousins (Chairman of Students' Committee).

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr. W. D. Sheers, "Electric Trams v. Motor Buses."

At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Mr. C. W. Salt, Chairman's Address.

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 10 a.m. The Right Hon. Lord Melchett, Presidential Address; Sir Henry Fowler, "Fuel Conservation in Locomotive Practice." Three papers dealing with "Economics of Coal Production and Distribution"—(1) Mr. G. Raw, "Production"; (2) Prof. H. Louis, "Preparation"; (3) Captain R. Addy, "Marketing."

Geological Society, Burlington House, W. 5.30 p.m.

Imperial Institute (Cinema Theatre), South Kensington, S.W. At 10.15 a.m., 11.35 a.m., 2.15 p.m. and 3.35 p.m. "India."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. (1) Dr. F. J. W. Whipple, "On the Association of the Diurnal Variation of Electric Potential Gradient in Fine Weather with the Distribution of Thunderstorms over the Globe." (2) Mr. N. K. Johnson, "Atmospheric Oscillations shown by the Micro-barograph." (3) By Mr. H. Jameson, "On the Mean Maximum Rain falling in a Timet."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Miss K. M. Carter, "Ovule Development and Meiosis on *Orobanche Minor*"; Dr. W. H. Van Seters, "Tripod and Pillar Microscopes."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Prof. Sir Thomas Oliver, M.D., "Lead Poisoning in Industries."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. E. V. Appleton, "The Indebtedness of Industry to Pure Science." (Lecture VI. "Electrical Communication and its Indebtedness to Physics.")

At the London School of Economics, Houghton Street, W.C. 5.30 p.m. Rt. Hon. Sir Halford Mackinder, "The Future of Transportation."

6 p.m. Mr. J. L. Fenton, "Sundstrand Adding and Book-keeping Machines."

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Dr. L. D. Barnett, "Wit and Wisdom in Ancient India."

At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lisica del Paradiso." (Lecture III.)

5.30 p.m. Dr. Paul Stamberger, "Colloid Chemistry and its relation to the Rubber Industry." (Lecture V.)

5.30 p.m. Prof. Dr. J. G. Robertson, "Swedish Romanticism." (Lecture III.)

5.30 p.m. Mr. W. C. Berwick Sayers, "A Modern Public Library at Work."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Early Distribution and History of the Slavs." (Lecture I.)

THURSDAY, NOVEMBER 22..Abattoir Society, Model, at the Royal Veterinary College, Great College Street, N.W. 5 p.m. Prof. F. T. G. Hobday, "A Survey of Humane Methods of Destruction, including the Use of the Lethal Box for small Animals." (Benjamin Ward Richardson Memorial Lecture.)

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Major T. M. Barlow, "Weight of Aircraft, with special reference to its Effect on Size."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Birth Control and Racial Progress, Society for Constructive, at the Essex Hall, Strand, W.C. 8 p.m. Dr. Marie Stopes, Presidential Address, "Details from 10,000 Birth Control Cases."

Chadwick Public Lecture, at the Guildhall, Bath. 8 p.m. Dr. E. P. Cumberbatch, "Physio-Therapy, with special reference to Medical Electricity."

Electric Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. L. G. H. Sarsfield, "The Electrical Equipment of X-Ray Apparatus." (Joint Meeting with the British Institute of Radiology.)

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 10 a.m. Symposium on "Fuel Control in Industry." Morning: Dr. Ing. F. Münzinger, "Electric Power Stations." Dr. E. S. Grummell, "The Chemical Industry." Messrs. A. J. Dale and A. T. Green, "Ceramic Industry." Dr. Geoffrey Martin, "The Cement Industry." Mr. T. A. Peebles. "American Practice and Experience." Mr. James R. Edwards, "Practical Results of Fuel Control." Afternoon: Mr. Martin J. Conway, "Liquid Fuel in Open Hearth Practice." Mr. J. L. Bentley, "Fuel Control in Open Hearth Practice." Mr. H. C. Armstrong, "Fuel Control in Re-heating Furnaces." Mr. J. B. Fortune, "Fuel Control in Blast Furnace Stoves."

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Ingleson C. Goodison, "Woodwork of the Walnut Period."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. E. D. Adrian, "The Mechanism of Nerves."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Prof. Eccles, "Pierre Corneille" (in French). (Lecture VIII.)

At King's College, Strand, W.C. 5 p.m. Dr. W. Robson, "Protein Metabolism." (Lecture IV.)

5.30 p.m. Dr. J. C. Hearnshaw, "Rousseau."

5.30 p.m. Mr. J. Isaacs, "Bunyan as Literary Artist." (Lecture III.)

5.30 p.m. M. Marcu Beza, "Roumanian Literature."

5.30 p.m. Mr. A. F. Meyendorff, "Tolstoy as a Social and Political Reformer."

At University College, Gower Street, W.C. 5.15 p.m.

5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 450-750 A.D." (Lecture IV.)

5.30 p.m. Prof. R. Coupland, "The After Effects of the American Revolution on British Policy." (Lecture I.)

8.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt." (Lecture I.)

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk Mirsky, "Tolstoy." (Lecture VII.)

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "The Sculptors of the XVth century." (I)

FRIDAY, NOVEMBER 23..Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7.15 p.m. Mr. R. Brooks, "Electric Traction on Railways."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) Dr. G. Temple, "The Physical Interpretation of Wave Mechanics." (2) Mr. Allan Monkhouse, "The Effect of Superimposed Magnetic Fields on Dielectric Losses and Electric Breakdown Strength." (3) Mr. Albert Campbell, "A New Potentiometer of Larson Type." (4) Prof. E. F. Herroun, and Prof. E. Wilson, "Ferromagnetic Ferric Oxide." A Demonstration of Emulsions showing Chromatic Effects by R. H. Humphrey.

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan (1829-1928)." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Mr. C. J. Gadd, "Assyrian Studies in the Past."

5.30 p.m. Dr. Edgar Prestage, "Afonso de Albuquerque, Governor of India."

5.30 p.m. Mr. G. B. Harrison, "Elizebethan Melancholy."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Collapse of Austria-Hungary." (Lecture VII.)

SATURDAY, NOVEMBER 24..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Ancient Egyptian Mummies."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. G. Whittaker, "North Country Folk Music." (Lecture II.)

United Service Museum, Whitehall, S.W. 3.30 p.m. Commander H. M. Denny, "Destroyers in the Great War."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3966. VOL. LXXVII.

FRIDAY, NOVEMBER 23rd, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 26TH, at 8 p.m. (Cantor Lecture.) FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, "Biology and Refrigeration." (Lecture III.)

TUESDAY, NOVEMBER 27TH, at 4.30 p.m. (Dominions and Colonies Section.) COL. H. L. CROSTHWAIT, C.I.E., "Air Survey and Empire Development." SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

WEDNESDAY, NOVEMBER 28th, at 8 p.m. (Ordinary Meeting.) J. H. ESTILL, O.B.E., Commercial Manager, Port of London Authority, "The Port of London." THE RIGHT HON. THOMAS WILES, P.C., will preside.

COUNCIL.

A meeting of the Council was held on Monday, November 12th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Atul C. Chatterjee, C.I.E.; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir Henry A. Miers, F.R.S.; Sir Francis G. Ogilvie, C.B., LL.D.; Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S; Col. The Master of Sempill; Mr. James Swinburne, F.R.S.; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society :—

Abel, John Stewart, B.Sc., Buenos Aires, Argentine.
Bex, Frederick George, London.
Bianco, Silvio D., London.
Fletcher, C. H., London.
Garg, Ganga S., Gwalior, Central India.
Godfrey, Frederick, Matlock, Derbyshire.
Griffiths, Thomas Henry, London.
Hiles, Henry Edward, Sibford Ferris, Oxon.
Kinred, Captain Hugh Cowell, M.C., London.
Sanderson, Harold, Denham, Bucks.
Varma, P. Deveshwar, Rawalpindi, India.

Mr. P. Morley Horder, F.S.A., was elected a Vice-President of the Society and a member of the Council in place of Sir Frank Baines, K.C.V.O., C.B.E., resigned on the ground of ill-health.

The report of the Departmental Committee on Examinations for Part-Time Students was considered.

Authority was given to complete the purchase of the eight cottages known as Arlington Row, Bibury, Gloucestershire.

The arrangements for the latter portion of the session were further considered.

A quantity of financial and formal business was transacted.

SECOND ORDINARY MEETING.

WEDNESDAY, NOVEMBER 14TH, 1928. THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., in the chair.

A paper entitled "English Silver and its Future" was read by MR. OMAR RAMSDEN, R.M.S. The paper and discussion will be published in the *Journal* on November 30th.

CANTOR LECTURES.

MONDAY, NOVEMBER 19TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the second of his course of three lectures on "Biology and Refrigeration."

The lectures will be published in the *Journal* during the Christmas recess.

BINDING COVERS FOR JOURNALS.

For the convenience of Fellows and others wishing to bind their annual volumes of the *Journal*, cloth covers can be supplied, post free, for 2s. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, NOVEMBER 9TH, 1928.

SIR HUGH T. KEELING, C.S.I., in the Chair.

THE CHAIRMAN, in introducing the reader of the paper, said he had done very distinguished work for the City of Madras in connection with water and drainage works.

The following paper was then read :—

TOWN WATER SUPPLY IN INDIA.*

By J. W. MADELEY, M.A., M.Inst.C.E., M.Am.Soc.C.E., M.Inst.W.E.

INTRODUCTION.

To-day we are to consider the supply of water to Indian towns.

The Madras Waterworks will frequently be referred to, because they are the waterworks that I know best in India, as it was my privilege to be responsible for their design, construction, and maintenance until they could be handed over as a going concern. They comprise nearly everything to be found in municipal waterworks in a typical Indian town. Reference will be made to British practice as occasion arises.

1. GENERAL CONDITIONS OF INDIAN TOWNS.

The large towns of India are situated in the Plains of a tropical country. Owing to the heat there is, for most of the year, a demand for water so great that it can hardly be appreciated in this country.

The people being poor, as measured by European standards, the Government usually pays half the cost of the works, and lends the remainder on generous terms. Even so, the funds are often inadequate for the supply required. These conditions cause the water supply problem of India to differ from that of England, where the people are generally better off and the climate cooler, and still more from that of America, where the population is the richest in the world and comparatively sparse, and where the quantity of water available is large.

Briefly, in the West the supply is usually regulated by the demand. In India it has to be adjusted to the quantity that the available funds can provide, and, as a result, there are few towns that can be supplied with as much water as they want. For instance, in Madras for twenty-four hours we endeavoured to supply the city with all the water it wanted, and although we did not quite

* Certain parts of the Paper as delivered have been omitted as they would be unintelligible without the lantern slides which were used to illustrate them.

succeed, the consumption was 23½ million gallons. All that can be supplied regularly is 16¾ million gallons a day, and that quantity was not intended to be reached till 1966. Thus the city has less water than it wants. The same is true of nearly all large Indian towns, and consequently the equitable distribution of the water is much more difficult in India than in Europe.

Most large Indian towns were originally, and many still are to a great extent, supplied with water from shallow wells and tanks. As the towns grew in size, the wells and tanks became contaminated with filth, especially the tanks where ablution was performed in the same water that was used for drinking. As a result the water supply became seriously contaminated, and a very high death rate ensued from cholera, dysentery and other water-born diseases. The Indians accepted these epidemics as visitations of Providence, and did little to stop them.

As the British obtained control of the country, they endeavoured to raise the sanitary conditions of the towns to the level of those prevailing in British towns, but found great difficulties, the principal of which were the callousness of the people, and their comparative poverty, which made it difficult to carry out works on Western lines. I have referred to the attitude of the people as callous; in reality it was at first hostile, on the ground that water that came through a closed channel, such as a pipe, would be unwholesome. This opposition was at first quite strong in Madras, but when the advantages of piped water became apparent, a strong demand arose that every house should be connected with the new system.

An amusing example of another attitude towards piped water was brought home to me when I was lecturing on water supply at a town some fifty miles south of Madras. After the lecture there was a discussion which disclosed that the general opinion was that a piped water supply was all very well in its way, but if it were provided for this particular town, what would the women do during the evening hours, which were then occupied in carrying water from the irrigation channels in earthen vessels? They gossiped enough as it was; what would they do if they had all this extra time?

2. Water a Valuable Commodity.

In England it is already becoming recognised that the supply of water, before long, will be insufficient to meet the demand if the latter continues to increase, as it has done of late years, through the introduction of baths and hot and cold water into all classes of houses, and it will soon be necessary to have recourse to sources which have hitherto been considered too polluted to be used for domestic supplies. Even in America the same problem is threatened in a few towns, owing to the large consumption due to having a separate bathroom for every bedroom in all the new hotels and living houses.

If this difficulty is felt in England and America, how much more must it be considered in India with its teeming population and its tropical climate,

making large quantities of water desirable for bathing and cleaning, and also for irrigation. Unfortunately the magnitude of the demand was not appreciated when the pipe water supplies were first introduced into the large cities of India. The supplies have been given on the lines of those of English towns. So far as I am aware, no town of the Plains of India has yet been able to supply as much water as the inhabitants desire. Bombay consumes about 60 gallons per head, Calcutta about 80, and yet both these towns are short of water. They are both spending large sums to increase their supplies, but I venture to think that these supplies will never be considered adequate by the inhabitants until it is appreciated that water is a valuable commodity,

Craig-Goch Dam.

and should be treated as such. Like gas and electricity, it should be supplied by meter and paid for according to the quantity used ; the monthly bill would then act as an automatic check on waste, and if waste were eliminated, there should be enough water for all legitimate purposes.

3. Alternative to Universal Metering.

Such a policy involves the universal metering of connections unless steps are taken to ensure that non-metered connections are made in such a manner that they cannot take more than their fair share of water. Acting on this principle, the following system has been worked out for Madras.

In very poor districts where the habitations are mostly mud huts, water is supplied only through fountains provided with self-closing taps. The fountains are about 200 yards apart, and from them water can be obtained and carried in vessels to the huts. Experience shows that the limited number of taps and the effort of carrying the water severely restricts the quantity used.

For brick houses two classes of services are provided:—

(*a*) *A first-class service*, for which the consumer is required to hire water meters from the Corporation, to adopt only specified fittings, and to secure approval of the position and number of pipes, taps and other fittings.

(*b*) *A second-class service*, in which the consumer is allowed to fix one ½-inch tap of approved pattern provided it is placed in a position, approved by the President of the Corporation, that is visible from the road, and can at all times be readily inspected by the Municipal staff. No supply pipe for a second-class service shall be of a larger bore than ½-inch.

The city imposes a Water Tax on property. Beyond this, no charge is made for water supplied through a second-class service. In first-class services the tax is taken to cover 100 gallons per rupee of rent. A charge of one rupee is made for every additional thousand gallons of water used.

These regulations were adopted by the Corporation and proved effective so long as they were carried out, but unfortunately exceptions were granted by the Council in such numbers that the regulations ceased to be effective and the control of the Madras supply has been, thereby, rendered very difficult. One reason for this difficulty is that caste men greatly dislike anyone of lower caste entering their houses.

I well remember going to see the house service of a Brahmin, who had complained that it was out of order. I went at my usual inspection hour, i.e., seven o'clock in the morning, but was informed that I could not be admitted because of some religious ceremony that was in progress. I went away, leaving word that I would return at 10.30, on my way to office. I did so, and was again informed that I could not be admitted because the ceremony was still going on. I, thereupon, told the owner, who had been brought to see me, that I should immediately cut off the supply to the house, and not restore it until I had made the inspection. He, thereupon, asked me to come in and see it at once! This shows that there was really no objection to my inspecting the water connection. If such difficulty is experienced by the head of a Department, it may be imagined what may be the difficulties of the ordinary inspector in cases where the owner does not wish him to see his water-wasting taps, and will give him two annas to go away.

4. SOURCES OF WATER.

Wells. To obtain underground water the most usual method is to sink a well, and most of the towns of India obtained their original supplies from shallow wells which became contaminated and dangerous as the towns

expanded. This method is very seldom used for new waterworks for Indian towns and no description will be given here.

Infiltration Galleries. There is, however, another method of obtaining subterranean water which is not unfrequently used in the Madras Presidency, viz., by means of Infiltration Galleries in gravel or sandy river beds which are dry for a large part of the year.

In such cases there is frequently an underground flow which may be intercepted, and for this purpose an infiltration gallery, constructed across the line of flow, is suitable. The gallery is formed by digging a trench in the bed of the river to the length and depth decided on, and laying open-jointed stoneware pipes in the trench, which is then re-filled with layers of broken stone or gravel next to the pipes, followed by layers of stone and sand, so

Tamarapakkam Anicut.

graded as to prevent sand from entering the pipes. Thus the gallery is a prism of sand and stone with the pipes near the bottom. The pipes lead to a circular masonry well sunk in the river bank. To this the water flows, and from it is pumped to the town.

Such a gallery is used for the water supply of Conjeeveram, about forty-five miles south-west of Madras. The old supply, obtained from shallow wells and tanks, was far from satisfactory, and when the works fell into disrepair, it was decided to abondon them and obtain a supply from the River Begabathi by means of an infiltration gallery.

A site judged to be as unpolluted as possible was selected, and a trench 560 feet long, 8 feet wide and 18 feet deep was dug across the river; the gallery was constructed as above described, the top of the prism being level with the lowest ascertained summer water level which is 10 feet below the average bed

level. The whole of the infiltration prism is thus permanently saturated. At the bottom of the prism are four rows of 9-inch stoneware pipes, with open joints, terminating in a chamber close to the edge of the river. From this chamber the water is carried through an 18-inch pipe to a suction well on the bank of the river.

The works, which were opened in 1897, were designed to supply a population of 56,000 with 15 gallons per head per day. The infiltration gallery is stated to have cost only £1,200, but those were days of cheap labour and a cheaper rupee.

5. Population to be Supplied.

The first step in determining the quantity of water required is to ascertain, as precisely as possible, the population to be supplied. In considering this question, it is necessary to decide what future increase shall be allowed for, so as to provide for future demands without imposing an undue burden on the present taxpayer.

In India, waterworks loans are subject to repayment over a period of from thirty to fifty years, according to the nature of the work, and thus it is necessary to estimate the population at some forty years after the works come into use so that the needs of the consumers may be provided up to the end of that period.

A study has to be made of all the census returns available and the possibilities of industrial development, so that the probable growth of the town, both as a whole and in its different divisions, may be estimated. The growth as a whole is required for the main works; the growth in divisions is required in order to determine the sizes of the mains required to supply the different divisions of the city.

It is interesting to observe that in Madras the increases for a period of forty years varied from 6.6% in the heart of the city to 114% in one of the suburban areas. These figures show how important it is to consider each area separately.

If a uniform rate of increase had been adopted throughout the City, the pipes would have been too small in some areas and unnecessarily large in others.

6. Quantity of Water per Head.

Having determined on the population to be supplied it is necessary to decide on the quantity of water required per head.

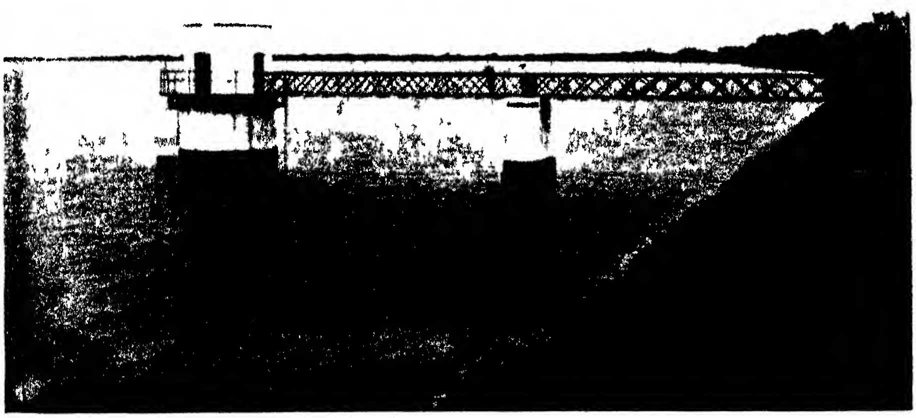
The consumption of water in Indian towns varies greatly. Thus we have Calcutta consuming 80 gallons per head per day and Bombay consuming 60 gallons per head per day.

But these amounts are very high compared with the average town where 30 gallons per head per day is about a maximum. In the Madras Presidency, 15 gallons per head per day is usually provided where at all possible. In communities where water is supplied through street fountains provided with properly looked-after self-closing taps, 5 gallons per head per day is found sufficient.

In the case of Madras City, after careful consideration, including, of course, the funds that were likely to be available, the writer, with the assent of the Government and the Corporation, worked out his scheme on a basis of 25 gallons per head per day. The population to be supplied at the end of the period for which the Government loans would be issued, was estimated at 660,000. Therefore, the quantity required is 660,000 x 25, i.e., a total for the city of 16½ million gallons per day.

7. DETERMINATION OF QUANTITY OF WATER AVAILABLE.

The quantity of water that can be obtained from any catchment area is the total rain that falls on the area, less that which escapes by percolation and evaporation, so that if the rainfall is measured, an estimate of run-off can be



Inlet Tower at Red Hills Lake, at beginning of the Madras Waterworks.

made in terms of the average rainfall which should be calculated over a considerable period, twenty-five years or more, if possible. The rainfall is determined by rain gauges placed at suitable positions in the catchment. If these have not already been established before the investigation is begun, the necessary gauges must be fixed as early as possible and their records carefully compared with pre-existing rain gauges on the catchment or neighbouring catchment, so that the falls at the new rain gauge positions may be determined in relation to the falls of the old rain gauges. It is usual to build reservoirs to equalise the flow of three dry years, and, therefore, the rainfall over three consecutive dry years is estimated by experts conversant with the meteorology of the district. The following example will show how the yield is calculated :—

Suppose the average annual rainfall is	45	inches.
Deduct one-fifth (say)	9	,,
Average for three dry years =	36	,,
Loss by evaporation and percolation (say)	14	,,
Available rainfall for storage	22	,,

Suppose the area of the watershed is 2,130 acres, then the available yield

$$= \frac{22}{12} \times 2{,}130 \times 4{,}840 \times 9 \times 6\tfrac{1}{4} \times \frac{1}{365}$$

= approximately 3 million gallons per day.

By a calculation such as this the available yield can be estimated.

The method described is often the only one available for preliminary calculations, but as soon as possible, actual measurements of discharge should be made by fixing gauges on the streams of the catchment. With the yield accurately measured, the size of the reservoir can be determined graphically by plotting, in terms of time curves representing the total yield and total supply for the longest period for which data are available.

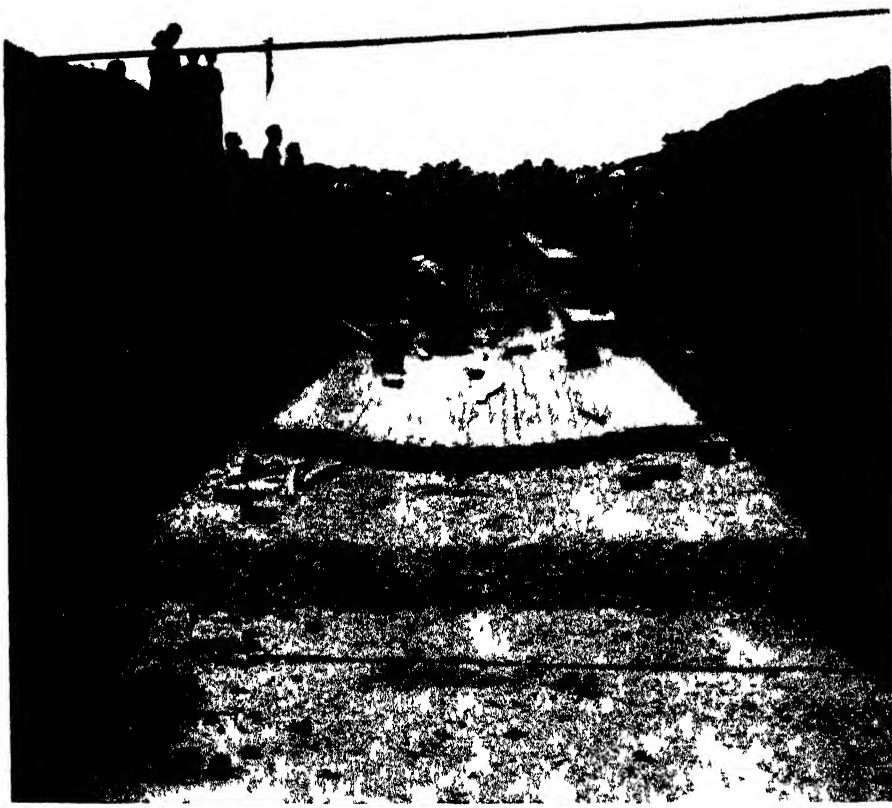
8. Slow Sand Filtration.

Practically all water supplies to Indian towns are subject to pollution, which may be dangerous. Some form of purification is, therefore, necessary. The most usual in this country and which, until recently, has been most usual in India, is slow sand filtration, which was introduced in England by Simpson, engineer of the Chelsea and Lambeth Water Company, just one hundred years ago. The filters he used are very similar to the slow sand filters of to-day, which consist of fine sand supported by coarser sand and gravel, through which are laid drains to convey the filtered water to tanks. The original purpose of these filters was to strain out the dirt and supply clear water, but after they had been in operation for some time it was found that the persons using filtered water were much freer from water-born diseases than persons who used raw water, and bacteriologists subsequently showed that slow sand filters, if properly run, would remove some 97% of the organisms in the water.

In addition, it has been found that storage up to about 30 days in England, and about 7 days in India, will remove a large percentage of the organisms, so that storage followed by slow sand filtration produces a very good water, where the conditions are suitable, and it is this method which, until recently, has been the standard for large towns in England and India, including the two largest—London and Calcutta.

The benefit derived from filtration is well shown in the case of Zurich, where there is considerable pollution of the raw water. To overcome this, slow sand

filters were introduced, and the typhoid death-rates in Zurich were reduced from an average of 73.6 to 9.0 per 100,000 population. What is probably the most notable example of the benefit of slow sand filtration is afforded by the cholera epidemic that visited Hamburg and Altona in 1892. Hamburg, with a population at that time of 640,000, and Altona with 150,000, are situated on the same bank of the River Elbe near its mouth. They form practically one city. At the date of the epidemic Hamburg drew its water supply, which



Madras Waterworks. Construction of Conduit.

was unfiltered, some distance above the city, while Altona took the same river water at a point eight miles down stream, *i.e.*, after it had received the pollution of the 800,000 inhabitants of the joint cities, but Altona's water was filtered. In Hamburg there were 8,600 deaths in less than two months, and in Altona about 300 deaths during the same time, and many of these were cases imported from Hamburg. Altona, using a highly-polluted water which had been filtered,

suffered very much less than Hamburg, using a much less polluted water which had not been filtered. The lower death rate in Altona can only be attributed to the use of the slow sand filters.

It is very important for the proper action of the filters that the water should be introduced on the surface at a uniform rate, and in such a manner that the surface film is not disturbed, otherwise the efficiency of the filter is impaired.

After a time, the surface film becomes so dense that the rate of filtration cannot be maintained. The filter is then emptied and the surface scraped. The surface of the filter dries up, the filtering skin curling into sheets which are removed by hand by women coolies. This skin is used for manure. Under it is a gelatinous layer of sand which is removed by means of "mamooties" and taken to be washed so that it can be used again.

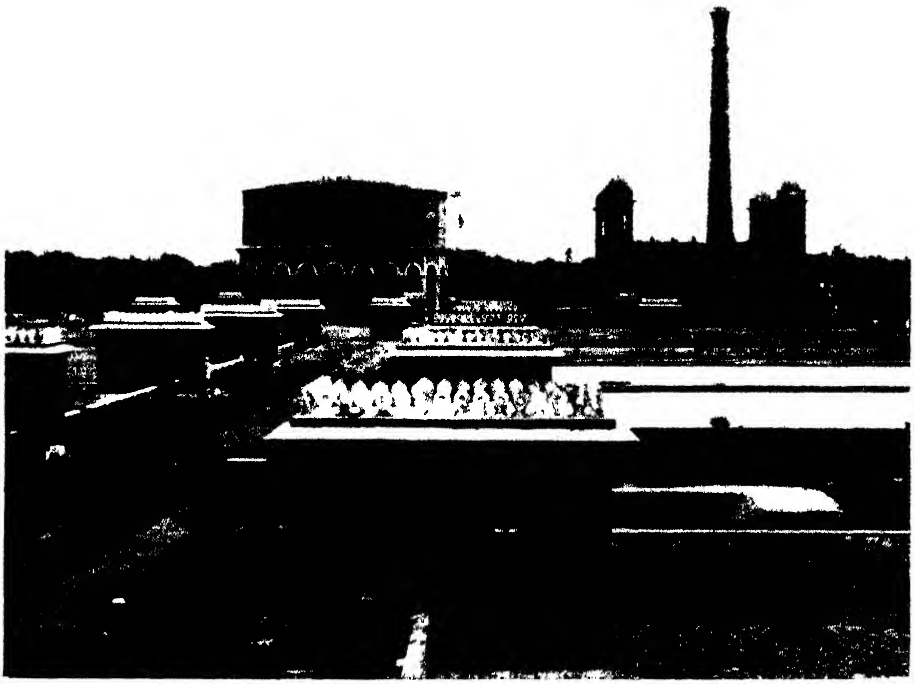
It is this gelatinous layer which is the essential part of a slow sand filter. The function of the sand is to form a framework which carries the gelatinous matter developed in the bed. The water passes readily through the jelly-like material, but the finest matter, even as small as bacteria, is held up.

In order that the gelatinous layer may be kept intact and not broken it is very important that the rate of filtration should be kept constant and should not exceed a speed which with most waters is 4 inches vertical per hour. The regulation is best effected at the filter outlet, where an automatic regulator may be fixed. As used in Madras, each of these regulators consisted of an outlet pipe 14 inches in diameter, capable of sliding up and down inside a closely-fitting cast iron pipe finished with a flat base. This has a right-angled branch through which the filtered water passes to the Filtered Water Conduit. At its top the sliding pipe is fitted with two weirs, each 15 inches long, attached to galvanised iron float tanks, so arranged that the weirs are maintained at a constant depth below the water and that the outlet can be made to discharge continuously at a predetermined rate. A screw is provided, by which the telescopic pipe weirs can be raised or lowered, relative to the floats, thus reducing or increasing the rate of filtration.

9. Pre-Filtration Treatment of Water.

The filter described above is not suitable for all waters, and some form of pre-treatment is frequently necessary. Most large rivers contain silt, which has to be removed in order to render the water suitable for filtration, the usual process being by sedimentation in large tanks, either with, or without, the use of chemicals. A notable instance of this preliminary sedimentation is afforded by Calcutta, where four tanks are provided each 2,036 feet long, with an average width of 277 feet and with a total capacity of 84 million gallons. The result of this treatment is three-fold: firstly, the sediment is removed to a very large extent; secondly, in settling, the sediment carries down a large quantity of organic matter; and, thirdly, the number of organisms is much reduced. Precipitation is obtained by adding alumina feric and

lime, with three days' sedimentation during the rainy season, and two days' sedimentation only during the dry season. With a silty water, such as that of Calcutta, this method is quite suitable as a pre-treatment for filtration through slow sand filters, and in the new works nearing completion, its use is being extended by the addition of two brick pre-settling tanks 200 feet wide and 100 feet long with three cross walls to save the cleaning of the settling tanks.



Madras Waterworks. Filter Beds with Control Houses in the foreground, and Pumping Station and Elevated Tanks in the background.

10. DOUBLE FILTRATION.

Another method of pre-treatment is to pass water first through rapid filters about 50 times as fast as through slow sand filters, thus removing a considerable quantity of the suspended matter, and to pass the effluent on to the slow filters. This method, as worked out by Sir Alexander Houston, has recently been used by the Metropolitan Water Board for part of the London supply, and is reported to be highly successful as an economic method of treating Thames water.

Experiments proved that with the Madras water double filtration would not be satisfactory unless alum were used, and if alum were used, no second filtration was necessary.

11. Failure of Slow Sand Filtration in Madras.

There are, however, cases where the cost of pre-treatment to render the water suitable for slow sand filtration would be too great to make it an economical method of producing a good water. This seems to be especially the case in India, where slow sand filtration has not proved altogether satisfactory in a number of towns. Madras is one instance. Here a filtering skin is duly formed, and for the first two or three months after starting, slow sand filters will work satisfactorily, but then analyses show loss of efficiency, and at the same time there is a smell of sulphuretted hydrogen in the neighbourhood of the filter outlet, and on emptying the filters, crater-like holes are frequently discovered in the surface. From careful observation it has been concluded that these are due to H_2S gas generated in the filter by organisms reducing the sulphates present in the water. This is confirmed by the fact that the crater-like holes and the irregularity in working only appear after the smell of sulpuretted hydrogen has become apparent at the filter outlet. Investigations showed that sulphuretted hydrogen was not formed with a rate of 8 inches per vertical hour or more, and it might therefore be supposed that to filter at this rate would be a solution of the trouble. The Madras water, however, contains organic matter in suspension of such a fineness as to be colloidal in character, and at higher rates of filtration than about 4 inches vertical per hour this matter is carried down into the sand to such a depth as to make washing the sand a serious mechanical problem, if the dirty sand has to be removed, washed, and replaced.

This obviously points to filters where the washing can be performed without removing the filtering materials, and the writer has recommended that the present slow sand filters should be converted into sedimentation tanks and rapid filters working at the rate of 100 inches vertical per hour with a chlorinating plant to be used as bacteriological analysis shows desirable. This might be continuously.

12. Rapid Filters.

Poona may be mentioned as another town which has changed from slow sand filters to rapid filters, and a number of towns in the north of India are doing the same. The essential film on the surface of the slow sand filters forms *slowly* by the deposition of matter in the water. With rapid filters an artificial film is formed *rapidly* by adding a coagulant, usually alum, or alum and lime, to the water. The gelatinous material produced passes well down into the sand and forms so strong a filtering layer, that water can be passed through at a very much higher rate than with the natural film of slow sand filters. Rapid filters have the advantage that, owing to the high rate at which the water is passed through them the area is small, and the filtering materials can be cleaned in place by means of an upward flow of water. Before filtration the water should be passed through sedimentation tanks, where a coagulant

may be added as required. After leaving these tanks, the water is treated with a dose of alum, in alum mixing tanks, and then passed on to the rapid filters.

On p. 41 is an illustration of a rapid filter installation which has been kindly supplied by Mr. Paterson, who has installed many rapid filters in India, including a set on works for which I was responsible.

The gravity type of mechanical filters are open at the top and the filtering head is provided by the difference in level between the inlet and outlet. The gravity type alone is usually employed for Indian town water supplies, for the water is nearly always dangerous or potentially dangerous. Where, however, the water is coloured but is reasonably safe, pressure filters can be employed. These are cylindrical steel chambers containing filtering materials, and are connected with the pumping main so that the water can be forced through the filter by the pressure in the main. The chemicals are added just before the water enters the filters. Hence the filter itself cannot be examined while in use and is not under the same control as the gravity filter.

For the purification of water for Indian towns the present tendency is to use sedimentation with or without chemicals, followed by Rapid Filtration. This method is used at Delhi, Lucknow, Allahabad and Poona. It has been recommended for Madras and Bombay, and only this week I have heard that, on my recommendation, it is to be installed at Trivandrum, the capital of the State of Travancore.

13. CHLORINATION.

However carefully sand filters are worked it is essential with many waters which are potentially dangerous, such as that of Madras, to secure another line of defence and that fortunately lies to hand in chlorine, which added in sufficient quantity will destroy all the organisms in the water. Originally chlorine was applied in the form of bleaching powder, and this still remains a very useful method in cases of emergency. Owing to the variation in the quantity of the available chlorine it contains, largely due to its instability, the necessary mixing, and the sludge which results when it is employed, it has been found better to use chlorine gas, which can be obtained pure and can be stored in steel cylinders so as not to be subject to atmospheric conditions. With the recently-designed apparatus, the desired dose of chlorine can be added with great precision. In India the "Chloronome" manufactured by the Paterson Engineering Company is the most commonly used instrument for regulating and administering chlorine gas to the water.

The steel cylinders containing liquid chlorine are connected directly with the Chloronome apparatus, and the chlorine passes in gas form to a filter which removes any dirt there may be in the gas, and then through two pressure reducing valves which maintain a constant pressure on the regulating valve.

The chlorine gas passes the regulating valve and flows through the meter down a central pipe to near the bottom of the absorption column which contains

a water-distributing tray and is packed with pumice. A small trickle of water is uniformly distributed over the pumice in its downward passage and absorbs the measured quantity of chlorine gas. The chlorinated water flows out from the bottom of the column to the main body of water to the sterilised.

It is nearly always preferable to add the chlorine to the filtered water in preference to the raw water, because the filtered water has a smaller and more constant organic content than the raw water, so that the chlorine dose can be more closely regulated, and there is less danger of taste and smell. In some cases, however, it is necessary to add chlorine before filtration, and sometimes both before and after, depending on the nature of the water.

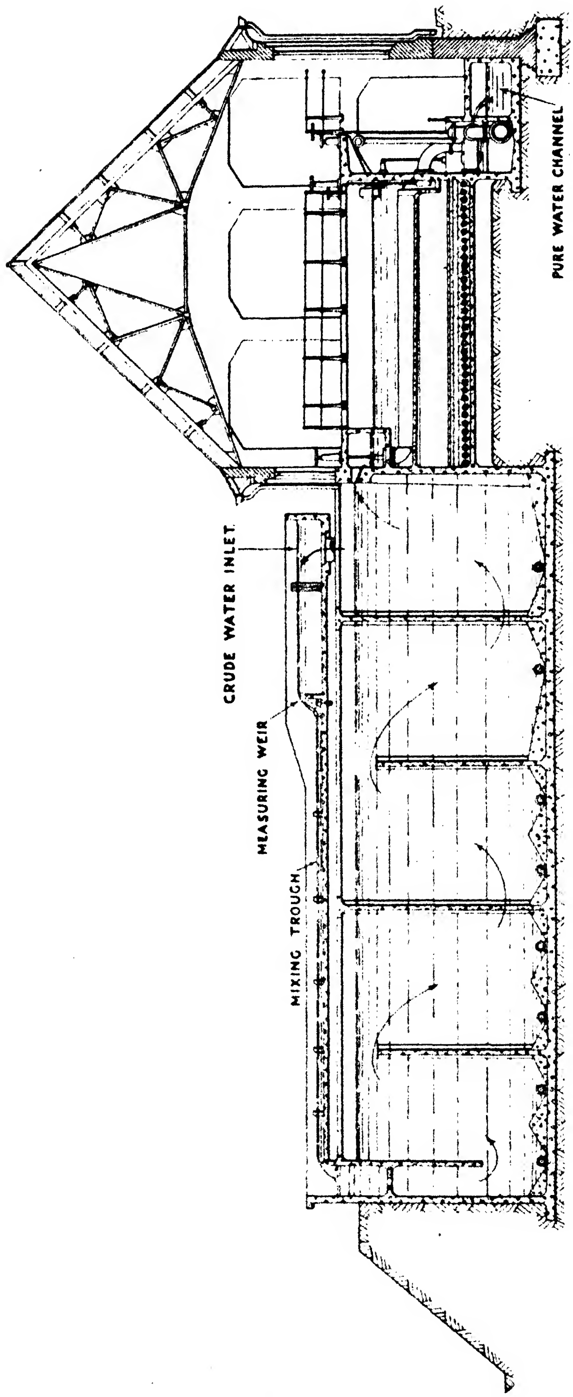
In America chlorine is used sometimes as the only treatment, and in India, so large a town as Bombay is at present relying on chlorine alone to purify its water. There is no doubt, however, that for water containing organic matter in suspension, chlorine should be regarded as supplementary to filtration, not as a substitute for it.

14. Filtered Water Tanks.

After purification, the water flows to filtered water tanks, which are usually below ground level. If by good fortune the filtered water tanks can be constructed at such an elevation as to be able to feed the town by gravity, the water may be taken directly from them into the distribution system. Almost universally, however, the level is too low for the town and pumping is required. In that case the filtered water tanks serve as a balance between the filters and the pumps so that the filters may work at a uniform rate night and day, while the pumps more or less follow the fluctuations of demand, pumping more than is filtered during the daytime and less during the night.

15. Pumping Station and Elevated Tank.

Assuming, therefore, that pumping is required, the filtered water tanks are connected to the sump of the pumps. In the Madras Pumping Station are three high duty pumps, each capable of raising 12,000 gallons per minute, which is the average rate of supply; two will deal with the maximum supply, and the third is a stand by. There is also a large Steel Elevated Tank to maintain a balance between the pumps and the demand for water for the distribution system. When the quantity of water pumped is greater than the consumption, the tank will store the excess, and will supply it to the city when the consumption is in excess of the quantity pumped. The tank is circular in plan, 104 feet in diameter, 28 feet deep from the overflow level to the flat bottom, and has a capacity of 1½ million gallons. In order to maintain an adequate pressure all over the city, the tank has been designed with its bottom 37 feet and the top of roof 73 feet above ground level.



Diagrammatic Section through typical Rapid Filtration Plant.

16. DISTRIBUTION SYSTEM.

The essential requirements of an efficient distribution system are :—

(1) To supply all consumers with an adequate quantity of water during the day.
(2) To maintain a sufficient pressure throughout the distribution system.
(3) To ensure perfect and rapid circulation of water throughout the entire system.
(4) To provide reasonable protection against fire.
(5) To provide means of detecting and stopping waste in a systematic manner.

17. MAXIMUM RATE OF SUPPLY.

The average rate of supply has to be determined for the main works, but for the distribution works it is necessary to determine the maximum rate of consumption, in order that the pipes may be designed of a suitable size. Thus, in Madras, where the average supply was taken at 25 gallons per head per 24 hours, an additional 20% was added for the hot weather. A higher figure was not taken because during the hottest weather a large number of consumers are out of Madras at hill stations, in Europe, and other cooler places.

Experiments on the flow of sewage led to the conclusion that maximum consumption might be taken as 2.4 times the average rate of consumption throughout the day. Even this figure does not allow for water required for fires, new moon days, and other festivals, when especially large quantities of water are used for bathing and house cleaning. Account must also be taken of the decrease in carrying capacity of the pipes, which occurs with age. In view of these considerations, the distribution system was designed so as to be capable of supplying water at a rate equal to three times the average demand, i.e., 75 gallons per head per day. In case the maximum demand exceeds the estimate, or the carrying capacity of the pipes decreases more than anticipated, it is proposed that balancing tanks should be erected to control the areas furthest from the pumping station. The tanks would be used to store water during hours of low demand and render it available during those hours that the demand is greatest, thus greatly increasing the capacity of the distribution system.

18. PRESSURE TO BE MAINTAINED.

The minimum pressure maintained in up-country towns in the Madras Presidency is about 10 feet above ground level. This is exceedingly low, compared with the usual practice in Europe and America; and Madras City, as the capital of the Presidency and the seat of Government, calls for something better. It was decided to provide a pressure of at least 50 feet above ground level at the ends of the principal mains, when the supply is at the rate of

25 gallons per head per day. This brings Madras into line with Bombay and Calcutta.

Unfortunately the Council have relaxed the rules and regulations which were formulated for the prevention of waste to such an extent that the Executive are no longer able to maintain throughout the City the pressure which was intended.

19. ARRANGEMENT OF PIPES.

The water from the pumps is carried by a 48-inch steel main for a distance of about 3,000 feet to a point where it branches into the seven mains which supply the seven water divisions of the city. There are, in addition, ten sub-mains supplying areas, any of which can be isolated. The sub-mains are arranged so as to ensure good circulation and distribution, and to restrict the area affected in case of the failure of a pipe.

Every closely built-up district is encircled by mains, in order that the cross distribution pipes can be fed from both ends. Dead-ends are avoided wherever possible.

To obviate closing large mains and the consequent interference with the water supply of considerable areas, large pipes are not tapped for house connections, but instead "rider mains" are used, laid parallel to the larger main and connected to it at both ends. In the system as designed, rider mains were provided for all pipes above 9 inches in diameter. Owing to lack of money, consequent on the war, some have been temporarily omitted.

20. PREVENTION OF MISUSE AND WASTE OF WATER.

The prevention of misuse and waste of water is one of the most important problems that face an Indian municipality.

Perhaps the most important duty of a municipality is to provide an adequate supply of wholesome drinking water throughout the area it controls. To carry out this duty, the co-operation of the inhabitants in preventing misuse and waste is necessary.

When it is stated that a single hole in a pipe of the size of a pin-head may cause waste of sufficient water to supply 50 persons, and that a hole as large as a pencil would waste sufficient water to supply 750 persons, it is obvious that a number of small leaks will render insufficient a supply which would otherwise be perfectly adequate to the needs of the people.

Owing to misuse the most ample of supplies may fail to meet the demand. For instance, a single tap left open all day for watering a garden may deprive a thousand persons of the necessary water for domestic purposes.

Loss of water may occur through wilful waste and improper use or through leakage from mains, house connections and house fixtures. Only by constant work can the loss from leakage of pipes, defective fittings, and unsound pipes,

be kept within reasonable limits. The writer has himself seen in Madras house service pipes with gaping rust holes and main pipes almost eaten through by rust, and when water mains are bared, it is common to find numerous house services leaking, and many small leaks would account for a large total loss which will be quite invisible in porous soils, such as sand or gravel.

Not only do these holes cause loss of water, but they provide openings through which the impurities from the surrounding soil may be sucked in when the pipes become empty. Several cases of serious illness have been traced to this cause.

The methods of detecting waste usually used in an Indian city are :—

(1) Limiting the number of connections.
(2) Metering every water service.
(3) House to house inspection.
(4) Waste-water meter system.

These are all put into use in a number of Indian towns. Bombay and Calcutta may be cited as examples, but even in these towns, it has been impossible to limit the waste effectively. In Madras all these methods are in use, though so far the waste-water meters have not been installed as originally intended, because although contract forms had been prepared before the Great War began, no work had been ordered, and the financial position since the War has not been sufficiently favourable to allow the work to proceed.

21. Conclusion.

I have now reached the end of my Paper, and will conclude by saying that an ample supply of wholesome water has probably a greater influence than any other single factor upon the health of the community, but, if the fullest possible benefit is to be derived from a water supply, the co-operation of every water consumer is needed. The mass of the population require to be taught that they must husband water, and that waste or pollution of water is a crime against society. I trust that those of you who are here to-day, and who have any interest in India, will assist in educating the public opinion of that great country to a full appreciation of the fact that "wilful waste brings woeful want," so that he who wastes wilfully may be regarded as an offender against the community. A proper public opinion thus formed will be a force which will act as a stronger deterrent than any rules, regulations or fines.

My last words will be a quotation from an American engineer, who writes : " Perhaps the greatest folly of our time is the almost universal attempt of cities and towns to increase their water supply plant to keep pace with their waste. It is a hopeless task. It amounts to the same thing as attempting to fill a pail which has only a sieve at the bottom. The amount of water which can be used is limited. The amount which can be wasted has no limit."

DISCUSSION.

THE CHAIRMAN said they were much indebted to Mr. Madeley for the very informative and instructive lecture he had given that evening, and he wished emphatically to endorse his concluding remarks about the waste of water in India. All classes of people in India, Europeans and Indians, were incredibly wasteful of the water that they obtained ; in fact, so much so that with possibly the exception of the United States he thought there was no country on the face of the earth where so much waste of water went on. He thought there were only two ways of controlling it : one was by a very extensive and careful system of metering on the distribution system, and the other—and possibly the more potent method—was to charge for what a man used. He had known Members of Council in Delhi object to their water bills, but the real facts of the matter was that the *mali* had left the tap running, and the demand made on the honourable member instead of being for a reasonable sum of money amounted to several hundred rupees for a month. When the reader was speaking about making dams in India he commented on the absence of plant for their construction. It was perfectly true that on the Periyar Dam, on which he (the speaker) had been a junior assistant engineer serving under a gentleman who was present that evening, Mr. Pears, the plant was conspicuous by its absence ; practically in the early stages of the dam the only thing on the works was the ordinary centrifugal pump. That day was passed. In September last he went to see a scheme which was being tested for the placing of concrete in a dam which was now under construction in the Madras Presidency. The structure contained a mass of 1,800 tons of steel, and was 311 ft. high, and consisted of chutes and mixers and measuring drums and everything that was required for the mechanical treatment of concrete, the material being run in on trucks, lifted up by hoists, placed in the measuring drums and mixed in the various mixers and shot down on to the dam. That enormous structure moved under its own power ; there were two of them, each operating from one flank of the dam. That great change in the method of construction was one of the consequences of the war. The ancient method of building dams in India took so long that a great deal of money went in interest charges, and in order to get rid of those as much as possible it was necessary to speed up construction, and the engineers in charge of the dam had adopted the expedient of using these enormous steel towers as a means of lessening the time required to construct the dam over the old methods previously in use in India. With regard to water pure and simple, he should have liked to hear from the reader some remarks about the cost of water per head. Before coming to the meeting he had looked up a few notes in his possession and had found that in some of the towns in Northern India—the United Provinces, for example—the cost of supplying water to the people in the towns, as given in the sanitary engineer's report at the time, was in Agra 3.8 annas, in Allahabad 3.6 annas, in Benares 3.5 annas, and in Lucknow 3.7 annas, which in English currency was round about fourpence per thousand gallons. It was well known what the charge in London was per thousand gallons, and there were towns in this country where the water charges were over two shillings per thousand gallons. In that respect, therefore, India was somewhat more fortunate than England. With regard to the capital cost, in three of the towns the capital cost of the works was somewhere in the neighbourhood of twelve rupees per head of population ; in England at the present time the capital cost was between £5 and £7, instead of sixteen shillings, which twelve rupees then represented. When the new capital in Delhi was under construction an important system of water works was devised and sand filtration abolished and the Paterson filtration plant used. He would

not bother the meeting with a technical description of the plant itself, as that had been fully covered by the reader, but he should like to mention that for two years previous to his departure from Delhi absolutely sterile water was supplied to the people and it made the very greatest difference in the health of the population. The cost at which that water was supplied was a little over three annas per thousand gallons, which included half the capital cost but not the interest on the Government loan to the municipality. The actual cost, as originally estimated before the war, worked out to about 12.58 rupees per head, but, as the greater portion of the work was only carried out after the war, that cost was raised to about eighteen rupees per head of the population. Probably a similar water supply in other towns in Northern India would cost about the same per capita. The engineer had many troubles in the East when dealing with such problems, and one of the reasons which led to grumbling when water works were opened in India was very often the time taken from the inception of the project to its conclusion. He knew of a case where the water supply of the town was first talked about in the year 1870, and time went on until 1881, when the engineer in charge submitted a scheme based on the population of the town. The matter continued to be discussed until another gentleman succeeded the originator of the scheme, who was sent home in 1884 to consult an engineer in this country as to what should be done. He returned in six months' time and the discussion was continued. A slight modification was made, and the scheme was eventually sanctioned in 1889 and work was begun in 1890. Money was dribbled out in small handfuls and the work was eventually concluded in 1899. The population meanwhile had considerably increased, with the result that the original estimate of water per head of population was reduced by 25 per cent., and consequently there was grumbling. All cases were not as bad as that, but there was very often a considerable amount of delay in the various processes that had to be gone through from the time of the inception of the scheme until its conclusion.

Mr. C. H. Bompas, C.S.I., said that one of the greatest benefits in India was a wholesome water supply. It was not always welcome. One great fact about it was that it had no claim to sanctity, which was a great difficulty in a town like Benares or Calcutta. But once people had the supply they appreciated its value and insisted on having as much of it as they could, and more if possible. The manner in which it was appreciated was brought to his notice in rather an odd way in the case of a prisoner in the Alipore gaol, who, after serving a long sentence, was about to be released and objected. He said, "For years you have had me in this gaol and I have drunk nothing but filtered water drawn from a boiler which blows a whistle, and now you are sending me to my village where I shall have to drink water from the village tank and I shall be dead in a fortnight." In Calcutta, the champion water waster in India, they were aiming at a supply of 90 gallons per head, and the reader had said that 25 gallons was enough for people. Much water was wasted in Calcutta. The present supply was about 70 gallons per head, but 30 gallons was unfiltered and only used for road watering and flushing, leaving 40 gallons for domestic purposes. The first thing the Bengali did was to build a reservoir in his yard under his tap and to keep that reservoir full, and, as the water supply was not continuous, the next thing he did was to tie back the spring and waste taps so that the water ran, and as the constant noise of trickling water might be annoying he generally put a piece of split bamboo or cloth from the tap to the reservoir and left the water running day and night. The unfortunate result was that the people in the south of the town furthest from the supply tank were short of water because the people in the north had practically exhausted it.

Although they were told the water could be provided if the people in the north of the town did not waste so much, no one was prepared to go in for stringent measures by metering every house and making them pay for the water consumed. That was not practical politics. No member of the municipality would get support if he proposed anything like that. They had now gone in for a very large extension of the filtered water supply which was supposed to be going to solve the difficulty, because it was thought that if there was a really continuous supply, so that a man could turn the tap on at any time and get water, the people would be content and would not insist on having their taps left open. He did not know how far the remedy would be successful, but it was certainly an expensive one. For the credit of Calcutta he should say that it had one very remarkable feature about its water works. A photograph had been shown of an elevated tank in which the water was stored so that it might continuously flow into the pipes and act as a balancing factor between times of greatest and least demand. The great water tank at Tollah was one of the most remarkable engineering achievements in the water works line in the world. It was desired to keep a reserve to supply the enormous demand for water at rush hours, and it was necessary to build a tank on the same lines as the Madras one, except that in this case it was a steel tank over 100 yards square, 16 ft. deep, and standing on columns 100 ft. high. It held 40,000 tons of water. It filled up during the night but all the water was drawn out by people in a few hours in the morning. The engineer who designed it was a brave man. Everybody prophesied the tank would not stand up or that an earthquake would knock it down, but it had proved a great success and justified the engineer, and he should like Calcutta to get credit for it.

Mr. W. T. Burgess wished to thank the reader of the paper for the information he had given with regard to the difficulties that water engineers had to deal with in average temperatures, which were very much greater than those in this country. A good many difficulties were met with in India which were quite unknown in England. The reader had referred to one instance, the formation of sulphuretted hydrogen in the filtered water in spite of the rapid rate at which the water was used. About four vertical inches was the average rate for slow sand filters, but when twice that rate was wanted they had to get over the trouble which had been brought about by the rapid growth of organisms. The troubles in these days were not quite as bad as they used to be, because there were now possibilities of making water sterile and absolutely safe by the use of minute doses of chlorine, which was something to be thankful for. In days gone by there was a prejudice against using chemicals of any sort for the purification of water; even lime was objected to because it was a chemical. Sulphate of alumina was looked upon as an objectionable chemical. Chlorine came into use before the war to some extent and was looked upon as objectionable, but after the war many learned to become accustomed to chlorinated water and appreciated the smell of it, and now they knew that if the water had that smell it was absolutely safe and they were getting over the prejudice, although even to-day there was some objection to the use of chlorine. Every water engineer who had put in a plant had occasionally met with troubles, but those troubles and the cost of overcoming them were gradually becoming known and remedies were being found, and he thought in the near future there would be very few who would hesitate to use chlorine for the final purification of waters that left a little bit to be desired in their present condition.

On the motion of the Chairman, a hearty vote of thanks was accorded to the reader, who briefly responded. The meeting then terminated.

OBITUARY.

TREVOR B. SIMON.—We regret to announce the death at Pittsburgh, Pennsylvania, on October 28th, of Mr. Trevor B. Simon, construction engineer of the Consolidation Coal Company. Mr. Simon graduated from the Ohio State University in 1907 and rapidly built up a high reputation as a mining engineer. He filled a number of important engineering posts, and, when the United States entered the war, did valuable service in the United States Army Ordnance Department. In 1921 he became President of the C. L. Miller Company, a position which he occupied until 1926. He was a member of the American Mining Congress, and of the American Institute of Mining and Metallurgical Engineers.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 26. . Actuaries Institute of, at Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. R. Thodey, "Life Insurance in Australia."

Chadwick Public Lecture, at University College, Exeter. 7.30 p.m. Dr. P. B. Ballard, "Open-Air Schools."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. E. S. Ritter, "Picture Telegraphy." At Armstrong College, Newcastle-on-Tyne. 7 p.m. Informal discussion on "Automatic Network Voltage—Regulating Equipments."

University of London, at the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton Watson, "The Little Entente and its Policy."

At King's College, Strand, W.C. 5.30 p.m. Rev. Claude Jenkins, "Decline of Dogma and the Anti-Dogmatic Movement."

TUESDAY, NOVEMBER 27. . Anthropological Institute, at Burlington House, W. 8.30 p.m. Prof. Sir Arthur Keith, F.R.S., "The Evolution of the Human Races." (Huxley Memorial Lecture).

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Informal Discussion.

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. H. W. Miles, "Agriculture of the Ormskirk Region."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. D. F. Campbell, "Electric Furnace Developments."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture II).

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VIII.)

At University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture III).

WEDNESDAY, NOVEMBER 28. . Automobile Engineers, Institution of at the Engineers' Club, Manchester. 7 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Informal Meeting—Exhibition of film of recent Canadian-American Tour.

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Dr. H. R. Hall, "Egypt and the External World in the Saite Period."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. Ordinary Meeting, 5 p.m.

Public Health, Royal Institute, 37, Russell Square, W.C. 4 p.m. Dr. H. M. Vernon, "The Fatigue of Heavy Industrial Work, and its Influence on Health and on the Duration of Working Life."

Science Guild, British, at the Goldsmith's Hall, Foster Lane, E.C. 4.30 p.m. Prof. J. Arthur Thomson, "The Culture Value of Natural History."

United Service Institution, Whitehall, S.W. 3 p.m. Captain L. D. I. MacKinnon, "The Work of the British Navy in the Far East."

University of London, at King's College, Strand, W.C. 5.30 p.m. Miss Doris L. Mackinnon, "The Indebtedness of Industry to Pure Science." (Lecture VII—"The Practical Applications of Zoology.")

At the London School of Economics, Houghton Street, W.C. 5 p.m. Rt. Hon. Sir Leslie Scott, "Proceedings by and against the Crown."

6 p.m. Mr. W. Dixon, "Dictating Machines."

At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lirica del Paradiso." (Lecture IV).

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jobson, "The Early Distribution and History of the Slavs." (Lecture II).

THURSDAY, NOVEMBER 29. . Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. F. Sigrist, "Production Problems."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Prof. Dr. F. G. Donnan, "Physical Chemistry in the Service of Biology."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. John C. Rogers, "Craftmanship of the Early Mahogany Period."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. E. D. Adrian, "The Mechanism of Nerves." (Lecture II).

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Prof. Eccles, "Pierre Corneille." (in French). (Lecture IX).

At King's College, Strand, W.C. 5.30 p.m. Mr. W. H. Wickwar, "Helvétius and Holbach."

5.30 p.m. Mr. Henry Wickham Steed, "Roumania in the New Europe."

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 450-750 A.D." (Lecture V).

5.30 p.m. Prof. R. Coupland, "The After Effects of the American Revolution on British Policy." (Lecture II).

5.30 p.m. Mr. H. Warren Wilson, "English Decoration in the Seventeenth and Eighteenth Centuries."

8.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt." (Lecture II).

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk Mirsky, "Tolstoy," (Lecture VIII).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "The Sculptors of the XVth Century." (Lecture II).

FRIDAY, NOVEMBER 30. . Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Prof. W. E. Dalby, F.R.S., "The Possible Vibration of a Ship's Hull under the Action of an Unbalanced Engine." (Thomas Lowe Gray Lecture).

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-upon-Tyne. 6 p.m. Dr. E. V. Telfer, "Frictional Resistance and Ship Resistance Similarity."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (1829-1928)." (Lecture IV).

At King's College, Strand, W.C. 5.30 p.m. Major H. W. V. Temperley, "Canning and Greece."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton Watson, "The Collapse of Austria-Hungary." (Lecture VIII).

SATURDAY, DECEMBER 1. . Association of Teachers of Speech Training, at the Royal Society of Arts, Adelphi, W.C. 10 a.m.

L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Montagu A. Phillips, "Bird Life."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. G. Whittaker, "The Violin Sonatas of William Young (17th Century)."

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FRIDAY, NOVEMBER 30th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 3RD, at 4.30 p.m. (Indian Section.) SIR JAMES MACKENNA, C.I.E., "The Sugar Industry of India." SIR REGINALD A. MANT, K.C.I.E., C.S.I., Member of the India Council, will preside.

Tea and coffee will be served in the Library before the meeting from 4 o'clock.

WEDNESDAY, DECEMBER 5TH, at 8 p.m. (Ordinary Meeting.) SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S., "Fuel for Ships." THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., will preside.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 21ST, 1928. HIS EXCELLENCY THE SWEDISH AMBASSADOR in the Chair.

A Paper entitled "Forestry in Sweden: its Importance to and Influence on Great Britain" was read by PROFESSOR E. P. STEBBING, M.A., F.L.S., Professor of Forestry at the University of Edinburgh. The Paper and discussion will be published in the *Journal* on December 7th.

CANTOR LECTURES.

MONDAY, NOVEMBER 26TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the last of his course of three lectures on "Biology and Refrigeration." On the motion of Mr. Arthur R. T. Woods, General Manager of the Nelson Lines of Steamers, a vote of thanks was accorded to Dr. Kidd for his interesting and instructive course.

The lectures will be published in the *Journal* during the Christmas recess.

REPRINT OF CANTOR LECTURES.

Reprints of the following Cantor Lectures delivered during last session are now available in pamphlet form and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2 :—

"Alloy Steels: their Manufacture, Properties, and Uses," by Professor H. C. H. Carpenter, M.A., A.R.S.M., F.R.S. Price 2*s.* 6*d.*

"Scientific Foundations of the Refining of Petroleum," by A. E. Dunstan, D.Sc., F.I.C., F.C.S. Price 3*s.*

"Fatigue Phenomena, with special reference to Single Crystals," by H. J. Gough, M.B.E., D.Sc., Ph.D. Price 3*s.*

"Acoustics," by A. G. Huntley. Price 2*s.* 6*d.*

A complete list of Cantor, Howard and other lectures which have been published separately in pamphlet form and are still available can also be had on application.

DOMINIONS AND COLONIES SECTION.

TUESDAY, NOVEMBER 27TH, 1928. SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair.

A Paper entitled "Air Survey and Empire Development" was read by COLONEL H. L. CROSTHWAIT, C.I.E., R.E. (retd.). The Paper and discussion will be published in the *Journal* on December 21st.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

WEDNESDAY, NOVEMBER 14TH, 1928.

THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, P.C., K.T., LL.D., F.R.S., P.S.A., in the Chair.

THE CHAIRMAN, in introducing the reader of the Paper, said that its subject, "English Silver and its Future," was a very comprehensive one. "English silver" no doubt meant English silver of to-day as well as English silver of bygone times, and, of course, the audience would get a view of the future from Mr. Omar Ramsden, based no doubt on his observations on present day problems. He thought, therefore, they could look forward to a paper which would deal with the prospects of applied art as well as with the powerful æsthetic aspects of that most charming craft. All present were well aware that Mr. Omar Ramsden stood in the forefront —if he was not actually the very first—among those who pursued that great and fascinating art.

The following paper was read :—

ENGLISH SILVER AND ITS FUTURE.

By Omar Ramsden, R.M.S.

It would be folly to dwell too much upon the past, for the present is ever with us, and our thoughts, most probably, are intent upon the future.

Nevertheless, some short consideration of the status and works of our ancestors is necessary to a proper understanding of present conditions and their bearing upon the days to come.

So much has been said on the question of Antique Silver, and its virtues have been so critically examined by antiquarian experts, that I should be the last to infringe upon their province. Moreover, please let it be understood

Fig. 1. Silver-Gilt Alms Dish, one of a set of four, for Westminster Abbey. Designed and made by Omar Ramsden.

that I yield to none in my admiration for the many really fine and beautiful pieces of silver which have come down to us through the ages.

On the other hand, one must have the greatest contempt for weak copies of their outward forms, copies which rarely have any of their inner virtues. As for reproductions—frankly made and sold as such—words fail me.

I think we may presume that the goldsmith and silver-worker of prehistoric and tribal times, and even those of Greece and Rome, were slaves—doing their best for their masters and having scarcely any other interests beyond their work: and that *time* was of no account so long as daily progress was made. Nor would there be any competition other than that of reputation and artistic standing.

As with every rule, there would be some exceptions: and the great name of Phidias at once suggests itself.

The early tribes and nations were governed in time of war by the brawny men of sword and club; in time of peace by the craft of what we now call the witch doctor, or the pagan priesthood. Both these classes had need of the artist, and until quite modern times, historically speaking, almost all the wonderful work made was to adorn the temples of the Gods or the persons of the warrior class.

For no national life is, or ever has been, complete without the work of the artist. His art may have been fine and sincere, or florid and spurious, according to how he was treated by his masters and the demands made upon him by the every-day circumstances of his time, but living art of some kind there has always been, up to about the year 1800. In the main things have changed but little, for still are our finest efforts devoted to the decorations of Mother Church on the one hand and the adornment of our women on the other; men having assumed a sombre uniform, largely, I presume, to avoid the expense of competition in costliness, which is the result of fine feathers on the human back.

We must not assume that the lot of the artist slave was necessarily unhappy. In fact, there is considerable evidence that he was petted and spoiled and, according to his ability, bought and sold at high prices, much as is the case nowadays with the star footballer.

You will remark that I have used the term artist; for, until the advent of the industrial revolution of the 19th century, all who made fine works in silver were artists—men who produced works of art by the creative gifts of their brains and the executive power of their hands.

For the matter of that, we must own that we silver-workers indeed, all workers—are still slaves:—wage slaves to mass-production, or bondsmen to "the bubble reputation." Personally, I care not a jot who and what may be our masters, so long as we turn out well-made and beautifully-designed pieces of work, all in our respective spheres.

After the tribal workers and the slaves of classic days came the great epoch of the cloistered monk, to whom we owe those lovely, if somewhat over-elaborated, articles of Early Irish Art, wherein the northern feeling for interlacing and mysterious patterns was robbed of its ancient Viking fierceness and made suitable to adorn Holy Church. The Benedictine order, with their fine motto *Laborare est Orare*, produced most of the art work of early medieval times, and the work done by and under our great Saxon Saint Dunstan must have been wonderful, judging by the few remains of his time and the writings about them which have come down to us.

It may seem strange to us moderns that a great man like Saint Dunstan should have found time to produce art work in gold and silver. Archbishop of Canterbury, Primate of England, and what we should now call Lord Chancellor, under, or perhaps I should say, above, four Saxon Kings, he raised England, for the first time, to the status of an international power. So great was his reputation as an artist in Gold and Silver that he was chosen as the Patron Saint of Goldsmiths. That powerful Guild which guides and controls the silver production of England still have a somewhat foolish, gilt, wooden statue of him, taken from their 18th century State Barge, standing in their splendid Hall.

After the iconoclastic workings of St. Bernard, and the " degringolade " of monkish efforts, we find that the finest work done under the Plantagenet kings is produced and controlled by the Medieval Guilds. They guarded the secrets of their crafts most jealously, and by strict rules and regulations held sway for centuries. They worked equally for the Church, the aristocrat and the rich burgher, not forgetting the rich burgher's wife, who was a very fine person indeed.

They were free men, free art workers for the first time in the history of Art. Truly they made the upholding of their rules and regulations a fetish and, indeed, were slaves to their own restrictions, which in the end were to prove their undoing, but these same restrictions enabled them to keep their work fine in quality and their members honest in their dealings, until they finally became a drag upon their efforts and killed all initiative.

Then came the Renaissance, which in Art, as in most other things, knocked down the old ways and standards like so many ninepins; knocked down, it is rather sad to relate, both good and bad.

In England and, indeed, in most Northern countries, the progress of Art was somewhat slow, and the Italian and pseudo-Classic never quite uprooted our conservative attachment to old styles. For, after all, the Renaissance, as applied to craftsmanship, was but a stilted catalogue of festoons, urns, masks, fluted columns and the like; all really foreign to our national Art feeling. It was of course very unsettling, and the result was a bastard Art, more quaint than beautiful at first, which blossomed out into the elaborate silver of the reign of Charles II.

But the Renaissance finally released the artist from all trammels, and for a time he revelled in his new-found liberty. Benvenuto Cellini, artist-goldsmith, sculptor, swashbuckler, author, genius and rogue, may be taken as a type of his age. Born in 1500, he came at the apex of the rush of new ideas, or the new use of old ideas, before they had time to stiffen into the curdled mass we call the Neo-classic, and the lighter, but still tiresome, thing we know as the Adam style. However charming this Adam work may be in architecture, I find its funeral urns, masks and swags wearisome in the extreme when applied to silver, and especially in the usual factory-made article.

As an extreme example of what has been perpetrated let us take the ordinary pepper-pot or sugar-castor of commerce. Starting on its career as a very fine Roman funerary urn, eventually finding its way into the Vatican or some such Roman collection, it was copied by men like the Brothers Adam—still a very live thing in its way—then copied by first-class silversmiths in London. After this follows a rapid descent of copy of a copy of a copy into "a good selling line" of, let us say, 1880 to 1890. Our second-class shops are still full of it, and its sisters, its cousins and its aunts. Finally, we had the Empire Period, or late Georgian, the last with even a vestige of a soul of its own; and then the Industrial Revolution of the 19th century—and the industrialisation of England.

For a time she was the "Factory of the World" in very truth, and everything, silver not excepted, was produced on commercial lines.

As a callow youth I was given a ponderous book—"The Illustrated Catalogue of the Great Exhibition of 1851." I hope most of you have never seen it for it is the most terrible and self-satisfied indictment that ever a nation produced against itself in the Court of Art.

The inevitable re-action was, however, on its way. Seen at first in the faint false dawn of the Early Gothic revival, with its somewhat foolish Strawberry Hill efforts, under the eye of Horace Walpole, to its death in the Houses of Parliament, under Pugin, it had its day and left its mark. The real dawn of a new day, a day whose sun is not yet at its zenith, took place in the world of Fine Art—in that wonderful band of painters we call the pre-Raphaelites, with its off-shoot, the sturdy effort of William Morris, whose ideas, leading to the arts and crafts movement, have profoundly affected the present-day world of applied art.

And his work goes marching on. Not only in England and Europe, but throughout the world.

He would not readily recognise many of the things of to-day as his great grand-children, but they are in a direct line of descent from his sincere if tentative efforts. Indeed, it is more than likely he would hate them.

It would take too long to follow the battledore and shuttlecock play that has been going on, seeing that, as a special subject, it would fill an evening. I would, however, just like you to realise how the New Gallery school was

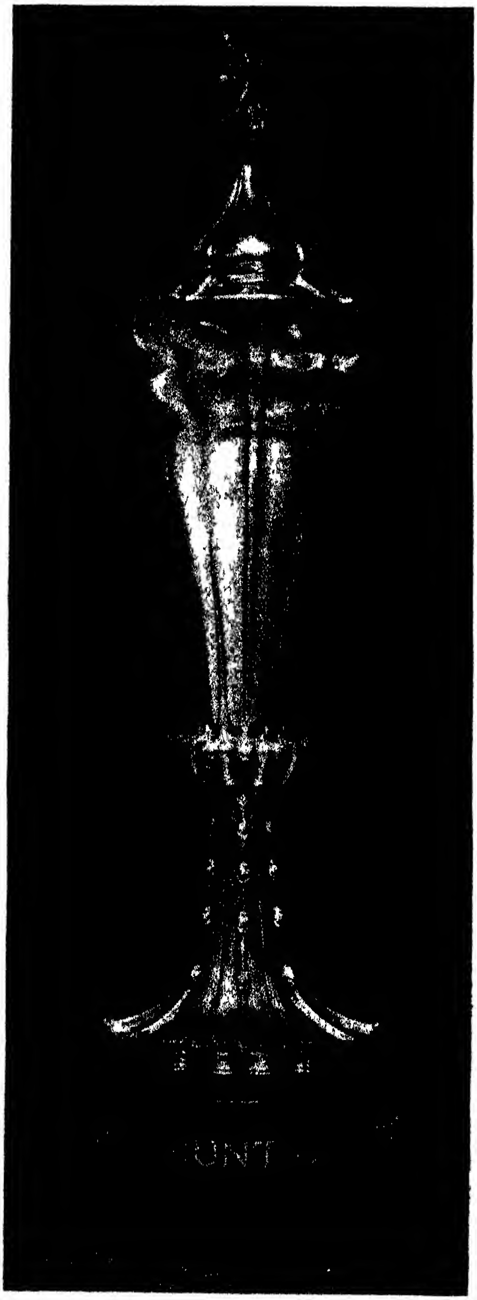

FIG. 2. The Royal Ascot Hunt Cup, 1928.
Designed and made by Omar Ramsden.

parodied by Glasgow, how Glasgow was outdone by Vienna, Vienna outshone by *L'Art Nouveau Bing*, and so on, leading to the intensely-regrettable cubism and other " isms " of our time. All these queer and awful happenings in the realm of the Applied Arts, which we so much deplore if we understand what Beauty is, will have their day also. They may serve to open the eyes of the artistic sluggard and to knock the tame stylist on the head. If so, so far, so good.

Some few examples will probably be preserved in the Chamber of Horrors like the Victorian rooms at the London Museum, but the mass will pass through the melting-pot to better things.

For Beauty is eternal and will triumph in the end.

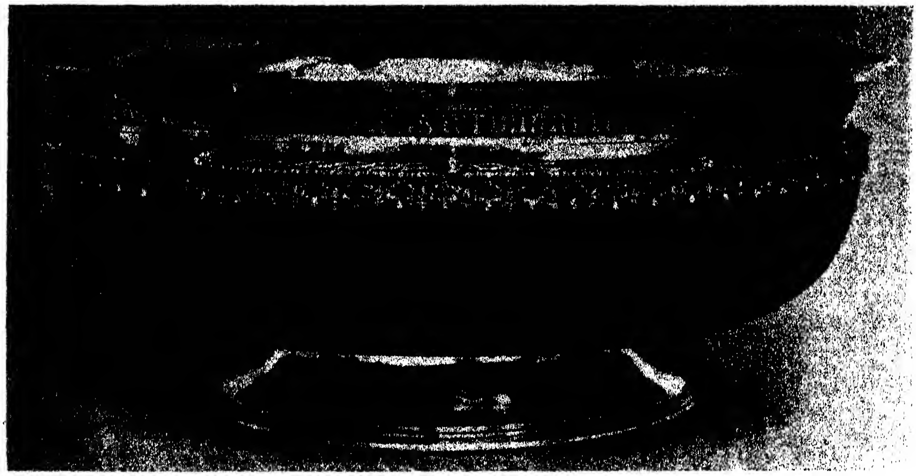

FIG. 3. Mazer, designed and made by Omar Ramsden.

I crave your indulgence for this all-too-rapid survey of past conditions, for it has been rather in the nature of a hop, skip and a jump over many things I would like to have spoken about. The works of great silversmiths like Juan Hapfe, Paul Lamarie, Storrs, and many others, have had no mention for we really have not the time for their consideration.

In fact, you may say I have said all too little about the silver-worker, but, after all, apart from a few anecdotes and the dry details of inventories and accounts, we know but little about him. It is his work that matters.

We have seen that he passed through slavery, monkery and guild-motes, into the radiant liberty of the Renaissance and the revival of wage-slavery under the Industrial Revolution. He now awaits the future.

What is the position in this present year of grace ? Every man will have his own ideas according to his outlook and personal experiences, so, having undertaken to say something about it, I can only survey it from my own studio window and the few facts picked up in considerable travel abroad.

It would appear to me that the Midlands have need of a very high protective tariff to keep out foreign silver while they take stock of their few advantages and scrap most of their old ideas. They need a breathing space badly, as far as I can see, but I wonder if they have the political initiative and power to demand this help from Government. Every other country enjoys this selfish advantage; why not England?

It enables a foreign country to charge a high price to its internal market and dump its surplus productions into ours at cut rates. A high tariff will not keep out goods of great artistic excellence, as is shown by the example of the U.S.A., where European goods of artistic merit are still imported and sold at high prices. Moreover, it can do no harm to the home buyer for, after all, silver, apart from the few household necessities, is a luxury, and no one is forced to buy.

This desire for a tariff protection by our great manufacturing towns is no new thing. When I was a boy, Sheffield cried for it because, it was said, foreigners produced work in imitation of her cutlery, stamping it with her marks.

The ground has shifted somewhat, I fear. If one wants a few really beautifully-made knives of a special shape, one must face ignorance and apathy of all kinds, and neatly-fashioned scissors on sale in places like Canterbury are found to be foreign. Moreover, agents for foreign wares have the confidence to send out pretty little lists of beautiful silver in which they practically say "Buy foreign silver, because it is best." They have no further need to hide in borrowed plumes, but are proud to come out in their own colours. Why?

Because they have discovered that applied-art ware sells on its art qualities. Unfettered by old dies, old models, and old ideas, they start on new ground. Aided by immense wealth accumulated in years when we were fighting for our lives, the neutral countries have been able to found fine schools of designers, to pay them well, and to put a new kind of factory-produced silver on the world market, about which I shall have more to say later on.

They have one other advantage, also, in the fact that the average British buyer likes to spend his money on foreigners, in the same way as he likes to hear foreign opera or dance to foreign jazz tunes.

As a nation we are inclined to believe that any art product, to be really fine, must have made a sea-crossing, and this in spite of the enormous prices paid, in the auction room, for the work of our English forefathers.

As a nation we have spent untold millions on a school of Art system which tends to bring forth more or less efficient producers of Art wares, but which seems to have had very little effect in educating the buying public to the proper appreciation of English art, either fine or applied.

Things are not so bad as they were a quarter of a century ago, it is true, but there is room for great improvement in public taste. During this summer I

was much struck by the large number of fine shops selling silver in the cities of Scandinavia. Corner sites which in England would be occupied by public houses or banks, have really wonderful displays of silverwork ; some cheap in quality and slight of merit ; some the work of artist-craftsmen, but all attractive in design.

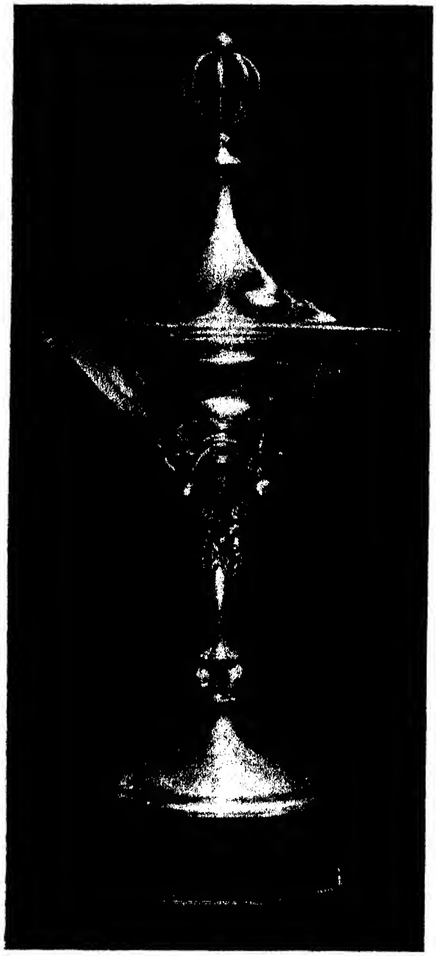

FIG. 4. Golf Challenge Cup, intended as an effort to get away from historic styles and conventional treatment. Designed and made by Omar Ramsden.

It is rather a reflection on our education to find that a small country of less than five millions total population—much less than that of London—is supporting some seven or eight well-known artists-in-silver, as well as large factories

for the cheaper wares. I am forced to the conclusion that, even allowing for a large export trade, she must use more and better silver per head than we do; moreover, that she knows and values Art and artist's work—a thing our manufacturers have still to learn.

One more remark, and I have done with the present and will pass on to the future. I refer to the curious way our English Committees of taste often select designs for important presentations from a competition of several invited firms.

I have been informed, over and over again, that, after a cursory glance at the drawings, the question invariably asked is: "What are the weights of gold or silver suggested by the would-be makers?" and that hands always go up for the heaviest, irrespective of any artistic qualities the designs may happen to possess.

Important firms, I am told, lend themselves to this curious form of "nugget giving" competition under the mistaken idea that it is a good advertisement to get the job, and that the public neither know a good design when they see it, or care for anything but weight of metal.

They do not know that some of the very finest pieces of silver ever made in olden times are of the thinnest gauge it is possible to employ, and that art-qualities, not weight, are the all-important points in any article that is to survive the test and judgment of time, and that design is most important and must be wedded to perfect workmanship to achieve a proper and pleasing result.

To attempt to forecast the future is a thankless, uncertain and dangerous undertaking. I can only say what I, as a student of my art and craft for some forty years, believe to be the trend of things.

In northern countries we can take good workmanship for granted, in the main; therefore it all resolves itself into a question of design. Personally I am inclined to believe there will be two quite separate and un-related bands of silver-workers in the future—a small band of artist-craftsmen who will gradually absorb all the important and unique work, such as church ornaments, presentation pieces for important occasions and for ceremonial purposes, and a larger—much larger—group who will work for factory production.

The latter will copy from the former, for, of course, the present dry-as-dust stuff will not last much longer. Good design in beautiful forms will hold the day both in studio and factory. One will act upon the other and in the end we shall have fine good work. Good factory-produced work for the masses and good, unique work for the connoisseur.

In England we have not yet attempted much on these lines, being full of faith in our old dies and models, but it will be forced upon us in time. When in Paris a few years ago I suddenly came upon a splendidly-appointed shop, full of beautiful silver and I thought a new thing had happened. I thought that here there was an artist-in-silver who had talent to produce and, what

is tremendously important, the capital to put his work on sale in a fine and attractive shop. But, when in course of time, I saw exactly the same things, in similar shops, in half-a-dozen European Capitals and heard of them in the cities of America, I realised that a new thing had indeed happened, but not what I had imagined.

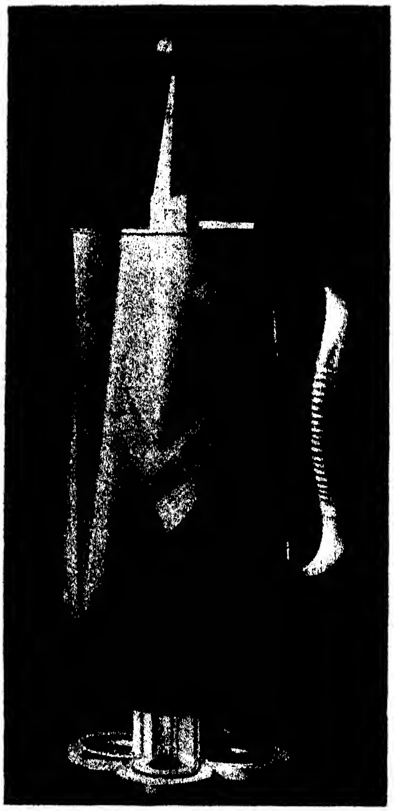

FIG. 5. Silver Jug. Designed and made by C. Müller, of Halle. A typical German effort to get away from the ordinary type of article.

I suppose one must say it is the relentless exploitation of an artist's name and work, in the world market, by almost unlimited capital. Truly it is a sign of the times and an indication of what must happen in the future of factory-produced applied Art. May we have the brains to copy its methods, but let us be true to ourselves and keep clear of its designs! Let us go one better, both in art and commerce; for we can. There is room at the top for all.

The recognition and appreciation of Beauty is not an easy matter for moderns who are untrained in art, because during the past hundred years or more our

thoughts have been turned in other directions. And this is not the time or place to discuss the Industrial Revolution of the last century, which is the cause of this; for mass production and cheapness have doubtless come to stay. Nevertheless, Art, fine or applied, is still an important factor in our lives; much more so than is realised by those millions who know little and care less about it. They are much to be pitied and should be helped to a better understanding of its delightful qualities in every possible way.

It behoves us to take stock of the situation before we, as a nation, take a back place. Much is being done in this direction by other European nations, who realise that Art is not only delightful but can be a real business asset. It is high time that ordinary people, for their own good and for the well being of England, should cease to regard Art as an exotic plaything of the rich. It really is a national necessity; we must begin to think!

Short cuts to effect, like the camera, the gramophone and the process colour-reproduction, have almost killed the faculty for honest mental effort, and lead us to expect all our joys to be neatly made by machine and served up in highly coloured cartons.

We must first of all endeavour to upset two very dangerous opinions which are in vogue among the mass of English people. First, the view so often heard, in words something like this: "I know nothing about Art, but I know what I like when I see it, and that's that"; secondly, the opinion, generally expressed with an air of finality, that, "We are only sure of Beauty in the presence of antiques." One might add, in passing, that juicy colour and pretty-pretty ornament are snares to catch the unwary, but sometimes have a little use if they start interest in an otherwise "Art-blank" mind.

Up to about 1800 it seemed difficult for men to produce really ugly work. It now seems the reverse. Grotesques there were in plenty; coarseness even, but always a touch of art-spirit. Yet there is no excuse, except mental laziness, for the present widespread non-appreciation of art by the lay mind.

A devoted and ever-increasing band of art-workers, who live and work in spheres over and above the domain of mass production, are placing before the eyes of those who can see, things of real beauty, and I venture to think that their works are equal to and often better than the much-prized antique. Different, of course, for we live in very different times, but splendid in their way; all they need is proper appreciation, their meed of praise and patronage.

Much of their work in the less costly materials is within the reach of the most modest purse, and it is extremely interesting to see the effect of even one object of beauty in some household hitherto lacking in that respect. I feel it has not yet become known that the worship of the antique is one of the great drawbacks to the modern craftsman. Cleverly worked up by interested parties, it has become a vortex into which is drawn the interest and money of just that class of well-educated and well-to-do people who would otherwise be his best patrons.

Unless I am mistaken, museums were founded for, and should be the best friends of the craftsman and designer as worlds of inspiration to fresh efforts but they seem to have become, at least in London, one of the principal aids of the antique dealer and the faker. It is even suggested, if one may judge by correspondence in *The Times*, that we should have examples of the faker's work placed side by side with the originals, in order, I suppose, to show how clever he has become in his artfulness. It all savours to me of collecting mania, of the idea that our museums should be complete collections of good and bad, instead of consisting of only the very finest objects of each class of Art-work. Moreover, we should have, as other nations all seem to have, a museum of all modern work. Work of the living as well as the dead should be on view.

It is true that many beautiful things are costly, but it should be realised that beauty is not the prerogative of wealth and lends her charm to the work of the humble village potter no less than to that of the most lordly state-aided porcelain factory.

It is also true that real beauty is seldom present except in due proportion to the amount of human thought and work that has gone to the making of a thing.

Exactly how the study of beauty should be approached is somewhat difficult to explain to the uninitiated, but a beginning may be made by an attempt to see what the creator of the work was aiming at when he evolved his design, what was passing through his mind, what were his particular difficulties.

Much can be achieved by representatives of our old families who have been brought up in an art-atmosphere—and there still are many in spite of modern conditions—by teaching the new monied classes, who are often eager to learn, how to approach the appreciation of Art.

It goes without saying that any work of art must be suitable for its position and purpose, so we will take that, the first principle, for granted. All the statues and paintings of ancient and medieval times, as well as jewellery and pottery, were created for a given position or person, and therefore each of them have certain qualities which are denied the easel picture or the modern mass-produced article.

The next step is to consider if the main lines and proportions are good and pleasing, and if these same essential parts grow out of the construction. At first all this may seem somewhat complicated, but it soon becomes a habit of mind—points being observed in a single glance. Most of us will pause to admire a May tree in full blossom and think how sweet it all is. How many see that tree not only as a white cloud of lovely blossom, but also as a finely-proportioned mass of green leafage, a massing of light and shade due to the way the branches and twigs distribute the bloom; the whole borne upwards on a twisted and fluted stem which has known the winter gale. In fact the same tree in winter with its wonderful anatomy, trunk, branch and radiating twigs, is almost as beautiful as when in bloom, seen by the seeing eye.

I admit that the wonders of modern progress have so filled our time that, in our hurried careers from one point to another at so many miles an hour, we have but little left for such pleasant studies. We *may* just take in the large and cubistical poster on the wayside, for it is designed to hit one in the eye, but we know not what we miss in our oblivion of art and nature.

It may be true, as some writers would have us believe, that we are groping out to the beginnings of a new style, and therefore must go back to the crude ideas of prehistoric man. I will not say "cave man," because some of the finest examples of pure line drawing are the work of what we call "cave man,"

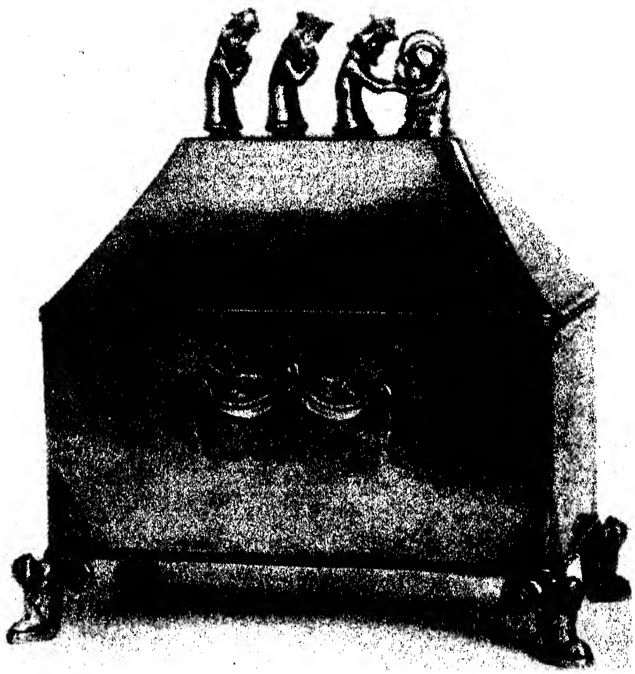

FIG. 6. Silver Casket, designed and made by Jacob Ängman, Stockholm. Illustrating the present-day Swedish effort towards simple forms and restrained ornament.

and the work of the savages of the South Seas—chip carving, mat weaving and the like—is really extremely beautiful, considering the circumstances under which it is made, and used.

Above all, let us beware of judging a work by its price. Let us not think a picture or a bowl is the more beautiful because clever dealers have forced its auction-room value up to colossal sums. Beauty is a thing apart from price ; which depends upon rarity and artificial forcing.

A set of the " Holy Grail " tapestries were recently sold at auction for some eight hundred pounds, well under one hundred a piece—this one of the loveliest creations of modern times. Burne-Jones does not happen to be in fashion. One day it will sell for fifty or a hundred times that amount. But its delicate beauty will be the same as ever, no matter its price at the moment.

A thing of beauty must be well made in addition to being well designed. On this point we can, in the long run, trust the latent feeling for good work which is native to our northern peoples. It was doubtless this Nordic spirit of beauty which led William Morris to revolt against his surroundings and to create his " earthly paradise," not only of poems, but of visible forms of applied art, and to initiate the present-day ever-growing productions of art work in which real beauty is present in ever-increasing volume.

There is, indeed, a danger of this fine movement being side-tracked by the present vogue for ugliness as a cult, but I have faith in the mental balance of the main body of people who will see it is, after all, but an advertising stunt to catch the eye of a world beginning to weary of exotic post-war conditions.

We may never recapture the exquisite, wonderful pleasures which are our birthright and which were enjoyed by all in earlier times, but we must make the effort.

As an extreme example of these mental pleasures of old, of which we have a written record, one may cite the story of François Villon, a poet, of the common people, who relates how, outlawed for some of his many peccadillos, starving, in rags, and with the watch upon his track, he was fain to pause in his flight to admire some piece of Gothic architecture, newly wrought in Paris.

At the other end of the medieval social scale we have great men like Louis XI of France, our Edward IV, and even Henry VIII, all busy with cares of State and family troubles, but all keenly interested in the art of their craftsmen. We have only to add our admiration for the country houses of England and the Burghers' mansions of Germany and Europe generally to see how innate to all, high, low and middle classes, was this great appreciation of beauty—beauty applied to the objects of ordinary use—to realise how full of pleasure their lives must have been.

I recently saw in the old Castle of Shokloster, in the middle of Sweden, a collection of some 2,000 pieces of medieval weapons, not one of which but was a work of art. So even the instruments of murder were produced by artists.

Sic transit gloria mundi. But we must recapture these lost glories of the world if we are to keep our place amongst the great nations many of which are now making fine efforts and with remarkable success.

We Britishers are said to be slow in the uptake, to use an Americanism, but it is usual for us to muddle through somehow to a successful issue. We are plodding along a somewhat dreary road at present and victory is not yet in sight.

But I have every confidence we shall win through in art matters eventually, as we have done in other walks of life.

Let us pull together, artist, designer, master and man, sinking small, mean differences for the common-weal and we shall have a splendid chance of regaining our natural position as leaders in the world of applied Art.

DISCUSSION.

The Chairman said that the reader of the paper in giving a survey of the art in which he was distinguished had also tendered a measure of advice and of philosophy upon the arts in general in Britain. He was sure they were all very grateful to him, not merely as a craftsman, but as a philosopher; not merely as an exponent of one particular art, but as an observer upon the wider uses which art, as art, imposed upon them. He did not dislike the controversial attitude which in one or two particulars Mr. Omar Ramsden rather provocatively assumed indeed in a way he liked him all the better for it. He liked his spirited attack upon the worship of the antique. He assured Mr. Omar Ramsden that, although they might over-worship the antique, in times past it had been by no means inconsistent with the most notable productions of the actual living. Mr. X—— was a crank on antiques more than any other living contemporary. Mr. Y—— was so great an admirer of antiques that he complained that he was not able to find enough to satisfy his desires, and he was therefore obliged to purchase bronze sculpture by Mr. Z——. Nowadays, a high percentage of antiques were forgeries, and if that fact could be impressed upon the buyers they would turn in despair to Mr. Omar Ramsden.

While he watched the wonderful series of pictures that had been shown, two facts had been impressed upon his mind. Firstly, so frank was the lecturer towards himself and history that he (the Chairman) would like to have seen fifty pictures of the author's own work with a narration beginning with the weaknesses as he saw them now by his experience and knowledge, and showing where progress was marked or otherwise. Secondly, in spite of the wholesale idea that tradition was a dangerous thing, it was a very difficult thing to escape from. Even if Mr. Ramsden were told to make a bell for the Royal Society of Arts, with a diameter of base of 2½ inches and a complete height of 5½ inches, he would find it very difficult to escape from the bell on the Chairman's desk. He had admitted already that he had been unable to escape from the traditional form of the mace, and they all knew that a teapot had very unescapable qualities.

He (the Chairman) believed they should not be afraid of tradition. It must be remembered that tradition was something which had survived a great many centuries and had an anchorage in the past; and it at least gave one a fixed point from which to start and towards which to recede, as well as a standard of comparison and a test of merit, at any rate of craftsmanship, if not of artistic values. Therefore, every craftsman to-day could profit by studying those gold vases of 3,500 B.C. which were dug up at Ur last summer by Mr. Leonard Woolley, which were notable for their complete absence of decoration—not one symbol or sign, nothing except form. Form was really the essential, and, as time went on, Mr. Ramsden was coming more and more to Form as the great basis of his art. The last picture he exhibited, the alms dish, was the finest, and yet it was the most simplified, of all Mr. Ramsden's work. The fact was that silver was a material that lent itself

more than any other to simplification. It was true that the bell by Reid Dick, which was among the earlier pictures shown, might have been in bronze. There was no reason why it should be in a precious metal. One of the Scandinavian works, and also an English one, struck him as adapting a design inherent in embroidery, which, for silver, seemed to him entirely wrong. He liked silver to be silver—to have the qualities of silver. There was a certain heaviness about silver. He had occasion to be on a Committee which presented a piece of silver to a very distinguished person a few months ago. It was a good heavy piece of silver, and the recipient said when he received the very handsome gift: "I like this so much that I should like to drop it on the ground and hear the noise it makes!" That was silver! They wanted something that was worth carrying away. Silver was not only a noble, but it was a very precious material, and there should be plenty of it—something thick, heavy and rich. He hated all the tiresome depreciation of British virtue that was so frequently heard. The older he became the more he admired the virtues and achievements of his fellow countrymen. It was quite true that to-day the artists of this country were not producing, as Mr. Ramsden stated in at least three different points in his paper, with the same vigour and vivacity as some of their Continental competitors, but it was possible to take comfort in the fact that in the past on more than one occasion and in more than one art they had led the world. In the Thirteenth Century there was produced in this country the Opus Anglicanum, an embroidery which was fully acknowledged by the greatest Popes of that period to excel all others. The finest embroidery of that period was English. If we did not excel all others we nearly rivalled all others in Church embroidery art. In an early stage of his paper Mr. Ramsden referred to one work done by the Irish. Technically, there was a masterly skill of handling, and in Dublin there was work among the finest of its kind in the world. Ireland had had distinguished makers in the past, and he hoped they would recur in the future. He supposed the Jacobean silver produced in this country was greater than the German silver of the same period. With reference to what Mr. Ramsden referred to as the Victorian Age, it had produced the pre-Raphaelites, whom he (the Chairman) admired, and it had produced William Morris, whom Mr. Ramsden adored. It started, it was true, mass production. They were always frightened of mass production. Why should they be, if the model was good? William Morris's books were good things, but William Morris's "Chaucer" would be no less beautiful if ten thousand copies had been printed instead of two hundred. He (the Chairman) would love to see a beautiful postage stamp reproduced by mass production, and tea-spoons and other things. They did know, however, that mass production was a very simple and convenient method of multiplying ugly things, and if he could share Mr. Ramsden's optimism on the subject and believe that breathing space would do them good, he might actually prefer the "nugget." He thought, however, that the breathing space was going to cause them to breathe a little too stertorously.

One delightful point in Mr. Ramsden's lecture was his question: Why not England? Why not, indeed! He hated the depreciation of themselves, and when he heard they were only producing bad work, and that in France, Germany, Italy or Spain they were producing good work, he would remind them that when they went to those countries they would see things just as ugly as in this country, and, in some places, ten thousand times more ugly. He thought they would win through by effort if everybody interested, not only in the arts, but in the greatness and the dignity of our country, would do everything possible to bring it about.

Sir Henry Miers, F.R.S., explained that he attended the meeting with no special knowledge of the subject of the lecture, but he desired to say how pleased he had been in following it. For many years, as an officer of the University of London, he had the pleasure of contemplating the mace of the University, but from what Mr. Ramsden had said that night he must no longer admire it. The great interest of the lecture to him was that it was the first example he had heard of an artist criticising himself and giving examples of his own works, and so to some extent revealing the workings of the artist's mind. He could conceive of nothing more interesting. He did wish, however, that Mr. Ramsden could have told them which, out of all the examples of his work, he considered the best. In regard to his statement concerning the museums of the country, he (Sir Henry) fully agreed with what he said about the absence of modern work. He would like to know how proper representation of work was to be achieved not only of original examples but of facsimiles. From what Mr. Ramsden had said, he believed he condemned all facsimiles and reproductions. Mr. Ramsden had shown by his work what a leading position he occupied in the working of precious metals, and he would like to say how much he had been moved by the very interesting lecture, and how much Mr. Ramsden had brought before them the value and importance of his work to the country at large.

Mr. G. R. Hughes (Goldsmiths' Company), said that on looking round he saw so many fellow members of the Goldsmiths' Company (including the last speaker) that the task of trying to say what the Company was doing in that connection was rather an embarrassing one. The policy of the Company could be summed up in one word—co-operation. It was trying to join forces with the Schools of Art, the individual craftsmen, the factories, and the retail silversmiths (which together formed the industry) in bringing prominently before the public the best modern silverwork that could be produced. That policy was worked out in various ways. First came the Company's collection of modern work. Mr. Ramsden spoke of the need for a museum of contemporary art. That was precisely what the Company was trying to form gradually in contemporary silverwork. Possibly one reason why such a museum had never been started in this country was the extreme difficulty of selection. They had experienced this in the case of silverwork. The selection rested with the Company's judges, of whom he saw at least three there that night. In the choice of the things they selected, they were open to criticism on every side. If they bought a museum piece from an individual craftsman it was said that it was not benefiting the trade; if they bought a mass-produced article of good form and design it was said that they were not helping the silversmiths' craft. The truth seemed to be, as Mr. Ramsden said, that there was scope for both individual craftsmanship and mass production.

On the whole, the collection had so far vindicated itself. It had been lent, sometimes at the request of a trade firm, sometimes of an art gallery, to Birmingham, Sheffield, Bath, Manchester, Darlington and at present part of it was at Oxford. Here it had had the severest possible test of standing side by side with four centuries of antique plate, and generally the criticism had been not unfavourable. One critic, it was true, in a paper, said that it represented the worst Nouveau Art of twenty-five years ago, which only showed that he had neither studied the Company's collection nor the history of the silversmiths' craft. So far all he had said dealt mainly with the question of bringing good work to the notice of the public and, incidentally, good designers to the notice of the trade.

Next came the difficulty of getting some of the best art students to go into the industry. They saw a wider field and better prospects in poster design and illustration work. That difficulty was being met to a certain extent by the granting of scholarships, and was, of course, dependent on improving trade. Two boys with travelling scholarships were abroad at the moment. The first had been four months in a Paris workshop and was now in Helsingfors; the second was attached to the Technical School in Munich under the care of Herr Lehr, of the National Museum, who had charge of the department of contemporary applied art which had been formed there. It was interesting that such a museum (as advocated by Mr. Ramsden) should already exist in Munich, and that a student in the silver trade should be in a position to see at first hand how this collection was being made.

Lastly, lectures and discussions were held from time to time at Goldsmiths' Hall, to which people who were concerned in the industry, from many different aspects, came. Not long ago Mr. Ramsden was the principal speaker, and that week Mr. Watts was giving two lectures on the Oxford Plate. A great many people came because these meetings gave them an opportunity of talking over what was happening. The object of the Company was to introduce artists to manufacturers, and salesmen to craftsmen, so that they might all go away with a better understanding of one another's point of view.

Mr. A. D. Bishop (Assay Office) said he came there that evening to listen to a very interesting paper, and in the hope that he would find the lecturer a true optimist. He had not been disappointed. Mr. Ramsden and himself had known each other for a number of years. He was with him as an optimist, but he thought that they would all agree that if the silver trade was to be placed in the position in which they all desired to see it, different methods would have to be adopted. In order to get a true perspective of the situation, let them consider some of the old masters in the trade. If they were fair they had to admire their work—the works that were included in the national collections, the private collections and in the wonderful collection at Oxford. He did not ask the meeting to look at them as antiques. Let them be looked at just for their worth. He thought they would agree that their works were very beautiful and well executed. When they looked at modern art, did the question ever enter their minds: "What would these old masters think of some of the factory-produced articles we see in the shops to-day?"

He would select for comparison Paul Lamarie. He was a man of note in his time. He rose to the position of Prime Warden of the Guild of Goldsmiths. He worked at the bench. Quite recently a man showed him a large collection of Paul Lamarie's works, and he made the remarkable statement: "Paul Lamarie must have had an enormous factory," and when he (the speaker) told him that Paul Lamarie worked in his shop with two assistants he was somewhat staggered. He thought that English silversmiths were, perhaps, the most generous workers in the world, because from time to time they had taken into their ranks foreigners and other people, and he thought that in most cases it had been found to be of advantage to the silversmiths. In recent years there had grown up a body who had attached themselves to the trade. They were described as artist-craftsmen, and to give them their full credit they had done some very wonderful and very beautiful work. But outside of these artist-craftsmen a number of other people had come forward, and these called themselves artist-craftsmen, but he thought that the less said about them the better, because their work was not helpful and it led nowhere.

He was reminded that when talking to these people they all seemed to have the idea that they should receive full value for their efforts. They seemed to forget

the fact that if a man was successful he was not only a good designer and a good craftsman, but one who could dispose of his goods as well. He hoped that they would bear that fact in mind, because there were a good many people in the world to-day, not only in the silver trade, but in other trades as well, who produced an article and said in effect: "I made it; now go and sell it." With regard to the question of a remedy for the present state of affairs, he thought things were bad, but the education of the British public was what he had always advocated. He could imagine some people saying "Good luck to you." He was fully aware of the fact that in England there was a large number of people who, when they had £10 to spend asked: "How large a cup can I get for the money?" But he was not discouraged by that. All of them could remember that years ago when they went down Bond Street they saw in the shop windows articles of jewellery of enormous size, such as huge cameo brooches, and large drop ear-rings. Could they imagine anyone having a collection of these to-day asking anyone to go and see them? No; on the contrary, he wrapped them carefully in a parcel and the next time he visited the jewellers he left them there and they started on their journey to the melting pot! In a comparatively short time a revolution had been brought about in the jewellery trade by the goldsmiths; and surely the silversmiths could do likewise. Therefore, he thought the sole remedy for the present state of affairs was the education of the British public—in other words, propaganda.

Mr. Omar Ramsden, in reply, remarked that most of the speakers had stated better than he had done what he meant to convey to the meeting. He thought the Chairman should really have delivered the lecture. So far as the Chairman's remarks went, there was very little to answer. He knew that the appreciation of antiques was a very old thing, in fact, the Renaissance was due to renewed appreciation of them; but there were many hundreds and thousands of imitations and fakes to-day. The other day he was giving a lecture at Oxford, and he spent a couple of hours at the interesting exhibition there. One thing struck him, and that was that, although it was a fine collection of exhibits and there was a full attendance of people looking at them, yet one could see a finer collection in South Kensington, for nothing, at any time—only it had not got a Press. This showed the value of a Press notice. He did not want to belittle anything at Oxford, but if one took away ten or a dozen of the finest pieces, there was nothing very remarkable about what remained. There were finer chalices in South Kensington Museum than he could find at Oxford. He was of opinion that we were inclined to "over-oxidise" our silver in these days, but it was easily removed if only the owner would give it a good brushing with powder or other material. With regard to what Mr. Bishop had said, there had been an enormous advance in the last 25 years. The main point he wished to make was not so much to point out the advance they had made, but to suggest that they might make a very much greater advance, and he hoped by showing what had been done abroad to spur them on to do a little better in England. As Lord Crawford had pointed out, there had been times when England had led the world, and at the beginning of the William Morris movement there was a chance that she would lead again, but the arts and craft movement as originated by William Morris, with the exception of one or two West End firms who had made a business of it, had been ignored; its potential influence had been overlooked and side-tracked. He believed the position could be regained, and he thought they should make an effort in that direction. In regard to the work of artist-craftsmen in England, this was far ahead of anything else being done in the

world. The ordinary run of manufactured stuff in this country was not up to the ordinary run of manufactured stuff abroad, but it was not so with regard to the work of the artist-craftsmen.

The proceedings concluded with a most cordial vote of thanks to Mr. Omar Ramsden, proposed from the Chair.

Mr. W. Augustus Steward writes: It is always necessary to look back as well as forward, as Mr. Ramsden has done, so far as what we generally term style or fashion is concerned; but we must also look back for the principles and the traditions underlying the production of the types evolved, the execution of the styles which have persisted.

What we are worrying about just now is the weakness in design rather more than the quality of workmanship. Design is often moribund for want of imagination and lack of encouragement, because patrons demand copies of old things from Georgian to Plantaganet; and because the designer has been more or less looked upon as the cheap factor in production—the person to put together in a somewhat new way such old models as may exist in a more or less well-equipped workshop.

Imagination is hardly demanded from one who is only required to play a game of patience with provided units. It is hardly needed; indeed, cannot be expected while weight and fashion rule.

But the failing is not entirely due to the lack of suppressed imagination or the demands of the modern economic situation. There is a factor which must be realised and appreciated if the economic situation were so revised as to give us free play. It is the understanding of the material in which the design has to be made. It is that practical understanding which has given Mr. Ramsden his position. It is the lack of that understanding which makes modern silver, no matter how produced, whether by hand or mechanical means, often so spiritless and unappealing.

Designers made in Art Schools have had no small part in retarding the Craft. Not until our silver designers have learned how objects can be made, what limitations are imposed and what possibilities lie in the metal—in a word, not until they can think out design in an understood medium—can we generally hope for a successful wedding of Art to Industry.

As for the past, were there castes of designers, smiths, chasers, etc., in the days of Abraham? I think not. Those remarkable examples of goldsmithing produced in Ur of the Chaldees were, in my opinion, thought out and executed by one man. Here is a point of great technical interest. In those far away days the workers in precious metals had already thought out and laid the broad foundations of the principles for the sound construction of forms to be made in precious metals. Forms and styles have varied, but the principles of construction have remained constant for over 6,000 years, and those ancient principles remained unchallenged until the mechanization of industry made possible mass production. We have to face that modern factor. We have also to fight the snare of novelty.

In the past we see that beautiful forms evolved from the simple objects which man, in his growing intelligence, produced for his use. Have we exhausted our fund of sane imagination or do our eyes fail us in the outlook? Surely we have something new to offer!

It is true that the possibilities of our Craft have been greatly exploited by craftsmen who learned how to fulfil all the requirements of a piece of personal, domestic

or ceremonial silver by the variation of standard forms, so that the numerous forms evolved have apparently left little for the creative spirit of us moderns.

But there is yet a great field in which we may work out variations indicating that we are not lacking in conception or knowledge of where to place rightly a pleasing or amusing fancy. Mr. Ramsden has demonstrated that.

In looking forward let us also think of the present in terms of machine production, for while our art may stand by the hammer our daily bread is, so to speak, ensured by the machine. The stamp and the spinning lathe are now largely used in the production of dozens of cups, all of the same shape and weight, also tea sets, and so on, to supply the general public at home and overseas.

We must look at the new factors in production without fear, and must not permit them to enslave us. There is no reason why the design should not be vastly better. It would be so if properly trained men were employed and manufacturers would not be so easily led away by the fetish of cheapness or the snare of novelty. That we have splendid exponents of silvercraft is beyond doubt. Several German manufacturers and craftsmen in silver recently said: "We have nothing to teach you (the English) in making silverware." They might have added: "your design for domestic plate—where it is not a copy of old patterns—and your gift or ceremonial plate would be a good beal better if thought had been put into it and cultured imagination given its opportunity." Given the patrons, we can, and do, produce things of beauty and a joy for ever.

I have been comparing the delightful old plate at Oxford with the examples of modern English work shown beside them and I came away with the feeling that we were not quite so badly off as some might think, thanks in no small measure to the inspiration of William Morris and the sincerity of his followers. That we have so many excellent smiths and some good practical designers is due to the foundation, by the old Technical Education Board, of the L.C.C. School of Silversmithing and Allied Crafts. But for that, plateworking, the raising and the shaping of an object with the hammer, would, by this time, have become almost a lost art.

It has been saved, and Mr. Ramsden's paper is but another appeal that a real effort shall be made by all concerned to raise silversmithing and its allied crafts to the enviable position maintained ere intense specialisation and other economic considerations began to undermine them.

For the present situation the manufacturers blame the distributor and the distributor blames the want of imagination on the part of the public. All are more or less to blame. Meanwhile clever craftsmen and designers have been easily attracted away to other callings where they can express themselves.

OBITUARY.

THOMAS BROUGH, J.P.—Mr. Thomas Brough, who died, after an operation, at Halstead, on November 13th, at the age of 52, was born at Macclesfield and received his early training at the Technical School of that town. He at once found his *métier* in designing, and after spending some time in the employment of Messrs. Grouts, textile manufacturers, of Great Yarmouth, he was subsequently engaged as designer by Messrs. Courtaulds, Ltd., in whose service he remained for twenty-nine years until the time of his death, when he occupied the position of chief designer. Mr. Brough was recognised as one of the leading authorities in the application of artificial silk to the textile industry and contributed a number of articles on the subject to *The Times* and the *Manchester Guardian*. He also read

a Paper before the Society in 1926 on "Artificial Silk," for which he was awarded the Society's silver medal.

Mr. Brough was a man of various interests and identified himself with a number of local activities. He was formerly President of the Halstead branch of the Workers' Educational Association, and at the time of his death was one of its vice-presidents. He also held a high position in the Masonic world, being a Past Provincial Grand Steward and Master of the Joshua Nunn Lodge. He had been a Fellow of the Royal Society of Arts since 1926.

NOTES ON BOOKS.

Modern Roadmaking, with Special Reference to Materials and Plant. By Harold Bradley and C. C. Hancock, with Foreword by Sir Henry P. Maybury and Introduction by Edward Willis. London: The "Contractors' Record," Ltd. Price 15*s*. net.

In the making of any book with a serious purpose there are two prime factors; firstly, a clear conception of the task to be accomplished, secondly, the degree of skill with which it is brought to a successful conclusion.

The authors, in the preface to this work, have most clearly visualised the task before them, and it may be said at once that the manner in which they have accomplished this is convincing and satisfactory, and has resulted in the production of a work which will fulfil its purpose as teacher and remembrancer, but best of all as a stimulus to thought, and to further progress and research.

There could not be a more opportune time for the publication of a treatise designed to set out in a compact and convenient form what may be described as the post-war conditions of road construction. The creation of the Road Fund, with its large annual revenues, and of the road policy based thereon, under the far-seeing guidance of Sir Henry Maybury, has produced an entirely new standard of highways work and efficiency measured in terms of highways traffic and user, and this has been in being a sufficient length of time to establish certain methods, and the merit of certain new principles.

The treatment followed by the authors is singularly appropriate and modern, and they have struck quite properly a nice balance between what may be termed professional practice and commercial conditions, recognising, as is indeed the case, that much of the evolution and change has arisen from special methods, special machinery and processes, which are the outcome of intensive industrial research and competition.

For the purpose in view, therefore, they have quite rightly ignored the historical side of British roads, most of which has already been adequately recorded by past writers. For equally satisfactory reasons the scheme of the book excludes such subjects as the planning and design of roads, etc., which would require a separate work.

The subject of construction, to which the authors have largely confined themselves, is by itself a wide and fruitful field of investigation, and the record and data compiled by them represent what may be termed good standard modern practice.

Their manner of putting before the reader the difficult question of surface construction is perfectly sound, and they wisely indicate future possibilities by referring to processes yet under trial and materials still in their infancy. For the first time a work has been issued which acts as a comprehensive guide on the inter-related

factors which go to make up successful road construction, and the authors have been at great pains to explain and set out in clear and unmistakable form the value to be placed upon such vital things as machinery, foundations, drainage, materials, etc. Certainly good construction has been their motto, and portions of the book can be read and re-read with fresh interest.

In quoting fully from actual specifications, whether of official or commercial origin, they not only furnish a standard and a clear insight into a difficult branch of this work, but provide an interesting basis of comparison.

Scant justice has been done to the bibliography of this interesting branch of engineering. Perhaps in the next edition this could be usefully extended to include many works which deserve to be better known and recorded.

The book as a whole, though there are occasional minor faults, can be most warmly commended. It helps to fill a gap which exists in English road literature, and will stand comparison with the many excellent American treatises. Its production has been most carefully thought out, and a word of commendation is due to the excellence of the illustrations. The use of colour for illustrating the sections of asphalt surfaces is most effective.

R.G.W.C.

Bells Through the Ages. By J. R. Nichols. London: Chapman & Hall. 21s.

I to the Church the living call,
And to the grave do summon all.

Thus runs the inscription on a Brighton church bell; and it would serve to remind us of what we are probably in no danger of forgetting—that for centuries the art of campanology, like other arts, was mainly practised in the service of religion.

But the original, the ultimate, the intrinsic virtues of this art are æsthetic, and they appeal to, and stir, our contemplative imagination. "'Tis at this hour," writes Vernon Lee, of sunset, "to the sound of bells, that the genius loci of old cities gathers itself up and overcomes one's heart." The sound of bells in an old city, or in a mountain valley, can convey to us almost more forcibly than anything else a sense of that "je ne sais quoi" which Anatole France said was "ce que la vie a de meilleur," adding, "et qui n'est point en elle."

The history and technique of campanology are interestingly described by Mr. Nichols for the general reader. We find that, as usual, the conceptions of our own time are neither more subtle nor more colossal than those of time past. Not in England, nor even in America, is there a bell to compare in size with the gigantic bell of the Kremlin, which was cast in 1734 and weighs more than 160 tons. However, three years after casting, the belfry caught fire, and since then the Tsar Kolokol has been nothing more than a curiosity. Our own biggest bell is "Great Paul," in St. Paul's Cathedral, which weighs nearly 17 tons and cost about £3,000. It is the largest *ringable* bell in the world.

Mr. Nichols has a good deal to say about the English bell-founding industry, since English bells are exported, not only to America, but to the Low Countries, where the arts of making and ringing bells had already reached a high degree of perfection several centuries ago. Our first known professional bell-founder, Roger de Ropeforde of Paignton, lived in the second part of the thirteenth century, while at Caversfield, Oxfordshire, is a bell that is supposed to date from the twelfth century.

In these early times bells were the objects of much superstitious feeling. They were solemnly baptised and christened, and in the popular belief had power to put

to flight evil spirits. Horace Walpole had, according to himself, a bell made by Benvenuto Cellini with which the Popes "used to curse the caterpillars." A charming tale tells how "all the bells in Europe were rung in 1456 by order of Pope Calixtus III, to scare away Halley's comet, which was supposed to be in some way identified with Mohammed II, who had just taken Constantinople." As the teller remarks, "the comet left, but Mohammed stayed."

It is probably not common knowledge that a "peal" of bells is any number of changes above 5,000, which can be rung by seven bells and over. However, it counts as a peal if five or six bells repeat their extent, *i.e.*, their full range, the requisite number of times to make up the 5,000. Twelve bells can ring 479,001,600 changes!

The art of ringing is not an easy one; it needs both knack and strength. A fine used often to be exacted from the ringer who "overthrew" his bell, the inconvenience of doing which is that it results in a broken stay as well as in a broken rhythm.

Mr. Nichols' book is certainly "authoritative," as the saying goes, and though the writer is a little inclined to call Shakespeare not Shakespeare but "that great master of the English language," it is also very readable.

P.B.

Atomic Structure as Modified by Oxidation and Reduction. By William Colebrook Reynolds, D.Sc. (Lond.), F.I.C., A.R.C.S. London: Longmans, Green & Co., Ltd. 7*s*. 6*d*. net.

As is partly indicated in the first and last sentences of his preface, this author has failed to comply with two very sound canons which, on this side of the Atlantic at all events regulate the form in which new contributions to the progress of the experimental sciences are promulgated.

The sentences in question run respectively as follows: "In this small volume the results of a theoretical investigation of the structural changes which occur in atoms during the processes of oxidation and reduction are recorded;" and "The size of the volume has permitted but scant reference to the publications of other workers and writers on the subject, but the timely appearance of Mr. Douglas Clark's 'Basis of Modern Atomic Theory' has made the compilation of bibliographies on this subject unnecessary."

It is an extremely valuable general rule, to which no doubt reasonable exceptions are to be made, that new matter must in the first instance be communicated to an appropriate learned society; and must have run the gauntlet of the publication committee of that society before being offered to the public with the authority of text-book form. Human nature being what it is, it would be idle to deny that hardship to individuals sometimes results from this rigid control, or that valuable ideas may sometimes have been temporarily suppressed; but no one with first-hand knowledge could doubt that the alternative would lead to far worse consequences.

In the present volume, not only is this sound principle contravened, but the reader is nowhere specifically informed that it has been so contravened: the scarcity of references to original sources is such that he might well suppose that Dr. Reynolds's views had previously been put forward elsewhere in the orthodox manner.

A second and still more vital principle, to which it is difficult to imagine any exception, is that, in whatever form new contributions may be published, no doubt must arise as to what portions of the matter are submitted as original, and what portions are due to previous workers. Unfortunately this rule also is neglected; and there are not lacking occasions on which a chemist or physicist, not being a

specialist in the particular subject of atomic structure, might be led to erroneous conclusions in this regard.

Dr. Reynolds begins by presenting a particular view of atomic structure, with reference to the extra-nuclear electrons, and by relating this view to the periodic classification of the elements. He then discusses in this light the rationale of atomic associations (using the term in its widest sense), the oxidation and reduction of organic compounds, the action of chromophores, the emission and absorption of radiation, the conduction of electricity through solids, and the phenomena of magnetism. In a final chapter he examines some of the difficulties inherent in any of the modern views of atomic structure, and puts forward views of the nature of electricity and ether.

While much of what he proposes is not lacking in interest, unsoundness sometimes occurs, as in the suggestion on p.22 to the effect that the phase-change from vapour to liquid may be due to a reversal of magnetic polarity in one of the paired shells of colliding molecules; a view which is probably to be connected with his belief, expressed on the following page, that in liquids "attraction prevails over repulsion." This last, of course, is simply not the case: all stable liquids require, like vapours, some external pressure to contain them in their existing volume, the mutual attractions of the molecules being quite definitely insufficient to prevail over the repulsions —though it is true that the disparity is in general less for liquids than for vapours. Furthermore, it is a familiar fact that a gradual change from undoubted vapour to undoubted liquid can quite easily be brought about by proper experimental means without the appearance at any stage of a discontinuous change in properties such as would mark the sudden reversal of magnetic shells.

With the above must be contrasted the much sounder view of liquefaction proposed on p. 110. To this one could not bring any objection, save that it is in the nature of a speculation unsupported by much definite evidence; an objection which, one fears, is only too applicable to a great part of the contents of the book.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 3..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Dr. L. A. Jordan, "Scientific Aspects of Paint Technology."

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as applied to Steam Generation."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. F. H. Mackintosh "A 'One Man' Borehole Outfit."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Captain B. S. Thomas, "The South-East Borderland of Rub' al Khali."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. J. A. Fleming, F.R.S., "Matter, Energy, Radiation, Life and Mind."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (1829-1928)." (Lecture V).

At King's College, Strand, W.C. 5.30 p.m. Rev. H. Maurice Relton, "Reconstruction of Dogma."

TUESDAY, DECEMBER 4..Chadwick Public Lecture, at 90, Buckingham Palace Road, S.W. 6.30 p.m. Mr. H. C. Adams, "The Drainage of Basements and Low-Lying Areas and the Prevention of Damp."

Civil Engineers, Institution of, Great George Street, S.W 6 p.m.

Colonial Institute, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Address by Mr. J. B. Walker on " eeking Successful Sett ers."

Electrical Engineers, Institution of, at the Technical College, Leicester. 6.45 p.m. Mr. H. Cotton, "Polyphase Commutator Motors and their Application."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 7.30 p.m. Colonel Sir Charles F. Close, "Some Aspects of the Work of the Ordnance Survey."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. A. G. Lobley, "Electric Furnaces."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture III).

Transport, Institute of, at the University, Bristol. 5.40 p.m. Mr. F. R. Imison, "Staff Organisation for Road Transport."

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture IX).

At University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture IV).

At Westfield College, Hampstead, N.W. 5.15 p.m Mr. Humbert Wolfe, "Verse and the General Reader."

WEDNESDAY, DECEMBER 5..Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Mr. A. Scott Dodd, "The Natural Occurrence of Boric Acid in Fruits." (2) Messrs. John Evans and A. O. Jones

"Chemical Tests for Drunkenness." (3) Messrs. C. A. Adams and J. R. Nicholls, "The Analysis of Mixtures containing Acetone Ethyl Alcohol and Iso-propyl Alcohol," (4) Mr. J. R. Nicholls, "The Specific Gravities and Immersion Refractometer Readings of Dilute Mixtures of Acetone and Water." (5) Mr. J. J. A. Wijs, "The Wijs Method as the Standard for Iodine Absorption."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Meeting of Wireless Section.

Geological Society, Burlington House, W. 5.30 p.m. Mr. J. Walton, "Recent Improvements in the Technique of Examining Fossils, and their bearing on the Nature of Fossilization"; Dr. K. S. Sandford, "The Erratic Rocks and the Age of the Southern Limit of Glaciation in the Oxford District."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. Stanley Hopkins, "Constant Pressure Thermal Storage."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Mechanical Engineers, Institution of, at Liverpool. Mr. W. A. Benton, "Weighing Machinery." (Joint Meeting with Liverpool Engineering Society).
At Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. F. C. Lea, Chairman's Address.

Metals, Institute of, at Thomas' Café, High Street, Swansea. 7 p.m. Mr. R. M. Doidge, "Refractories."

Microscopical Society, 20, Hanover Square, W. Meeting of Biological Section.

North-East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. H. A. Morham, "Feed Water Heaters."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Dr. R. Fortescue Fox, "Rheumatism in relation to Industry."

United Service Institution, Whitehall, S.W. 3 p.m. Wing-Commander R. B. Maycock, "The Employment and Development of Flying Boats."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. Ruggles Gates, "The Indebtedness of Industry to Pure Science." (Lecture VIII—"The Relation of Botany to the Grain, Rubber and Cotton Industries.")
At the London School of Economics, Houghton Street, W.C. 6 p.m. Captain Vaughan, Demonstration of the Ellis Book-keeping Machine.
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Dr. J. Percy Bruce, "Liu Pang; one of China's Rebels."
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lirica del Paradiso." (Lecture V).
5.30 p.m. Prof. A. E. Richardson, "The Housing of Books."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Dragutin Subotic, "The History of Serbo-Croat and Slovene Literature in the 19th Century." (Lecture I).

THURSDAY, DECEMBER 6..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Capt. A. P. Thurston, D.Sc., "Control of Aeroplanes by Alulas."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. U. R. Evans, "The Mechanism of Corrosion." (2) Messrs. E. H. Farmer and W. D. Scott, "Properties of Conjugated Compounds." Part VI.—"The Dibromination Products of Cyclic Butadienes." (3) Messrs. E. V. Bell and G. M. Bennett, "The Stereoisomerism of Disulphoxides and related Substances." Part IV.—"Di- and tri-sulphoxides of Trimethylene-trisulphide." (4) Messrs. G. M. Bennett and G. H. Willis, "The Structure of Organic Molecular Compounds."

Chemical Engineers, Institution of, at Burlington House, W. Conference on Drying. 10.30 a.m. Mr. S. T. C. Stillwell, "The Seasoning or Drying of Timber"; Mr. A. T. Henly, "Tunnel and Stove Drying." 2.30 p.m. Mr. J. A. Reavell, "Film and Spray Drying"; Prof. J. W. Hinchley, "Drying by Pressure."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. A. E. Foster, P. G. Ledger and A. Rosen, "The Continuously Loaded Submarine Telegraph Cable."

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. W. S. Sparrow, "English Furniture and Woodwork from 1750 to 1800."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. F. C. Lea, Chairman's Address.
At Glasgow. General Discussion on "Steel Castings." (Joint Meeting with Scottish Branch, Institute of British Foundrymen).

Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Dr. Ezer Griffiths, "Research Carried out for the Engineering Committee of the Food Investigation Board during 1927."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir R. Paget, "Human Speech and Expression by Gesture."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Prof. Eccles, "Pierre Corneille." (In French). (Lecture X).
At King's College, Strand, W.C. 5.30 p.m. Mr. C. H. Driver, "Morelly and Mably."
5.30 p.m. Mr. Ifor L. Evans, "Modern Roumania: Economic Reconstruction."
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 450-750 A.D." (Lecture VI).
5.30 p.m. Prof. R. Coupland, "The After Effects of the American Revolution on British Policy." (Lecture III).
8.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt." (Lecture III).
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Soyatopolk Mirsky, "Tolstoy." (Lecture IX).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "Michael Angelo."

FRIDAY, DECEMBER 7..Chemical Engineers, Institution of, Burlington House, W. Conference on Drying. 10.30 a.m. Mr. T. J. Horgan, "Rotary Dryers"; Mr. G. W. Riley, "Vacuum Drying." 2.30 p.m. Dr. S. G. Barker, "The Hygroscopic Nature of Textile Fibres"; Mr. B. J. Owen, "The Drying of Agricultural Products"; Mr. A. Chapman Barnes, "Some Drying Problems in Tropical Africa."

Chemical Industry, Society of, at the Geographical Hall, Manchester. 7.30 p.m. Dr. Aner, "Colloid-Chemical Changes in Rubber and other Unsaturated Organic Compounds."

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. C. H. Faris, "The Application of Electro-Deposited Metals to Engineering."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Mr. J. G. C. Leech, "St. Austell Detritals." Mr. H. G. Smith, "Some Features of Cornish Lamprophyres."

Junior Institution of Engineers, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Lt.-Col. J. T. C. Moore-Brabazon, Presidential Address, "The Future of Coal in relation to Industry."

Mechanical Engineers, Institution of, Storeys' Gate, S.W. 7 p.m. Mr. E. T. Elbourne, "Marketing Engineering Products Overseas."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne, 6.30 p.m. Mr. K. O. Keller, "Combustion and its Difficulties in Marine Oil Engines."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. F. W. Thomas, "Weak R. in Central Asia."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Sydney Smith, "BabylonianAmulets." 5.30 p.m. Sir Mark Hunter, "Shakespeare's Clowns."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "England and Bohemia." (Lecture I).

SATURDAY, DECEMBER 8..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Robert Aitken, "Life and Traditions in the Spanish Rioja."

Royal Institution, 21, Albemarle Street, W. 3 p.m., Mr. Walter Bayes, "The Gulf between Painter and Public."

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FRIDAY, DECEMBER 7th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, DECEMBER 12TH, at 8 p.m. (Ordinary Meeting.) G. G BLAKE, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice." SIR OLIVER J. LODGE, M.A., LL.D., D.Sc., F.R.S., will preside.

FRIDAY, DECEMBER 14TH, at 4.30 p.m. (Dominions and Colonies Section.) THE RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D., "The Improvement of Negro Agriculture." DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.L.S., F.R.S., will preside.

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 28TH, 1928. THE RIGHT HON. THOMAS WILES, P.C., in the Chair.

A Paper on "The Port of London" was read by MR. J. H. ESTILL, O.B.E., Commercial Manager, Port of London Authority. The paper and discussion will be published in the *Journal* on December 28th.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows :—

LECTURE I—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 21ST, 1928.

HIS EXCELLENCY THE SWEDISH MINISTER in the Chair.

THE CHAIRMAN said he felt greatly honoured at being invited to preside over a meeting held in connection with the Royal Society of Arts, which had exercised such a great influence in the life of Great Britain. The lecturer, Professor Stebbing, had just returned from Sweden, where he was sure he had made many friends, and he was confident the lecture would prove of very great interest.

The following paper was then read:

FORESTRY IN SWEDEN: ITS IMPORTANCE TO AND INFLUENCE ON GREAT BRITAIN.

By E. P. STEBBING, M.A., F.L.S., F.R.S.E.,

Professor of Forestry, University of Edinburgh.

Some years ago during the War, as an outcome of investigations I had been carrying out for several years into the timber resources of the World, especially the resources in soft woods, I had occasion to write two papers, the one dealing with the forestry resources of Sweden, and the other with those of Finland. In the short period of a decade and a half the forestry position of both countries has changed very considerably and in several interesting and important directions.

Considerable attention has been recently drawn to Sweden, her forests, and forestry problems, owing to the enthusiasm and *éclat* with which the Centenary of the State Forestry College was recently (October, 1928) celebrated

at Stockholm and the publicity given to the proceedings. Numerous delegates from foreign countries attended the celebrations, which were graced on several occasions by His Majesty the King and Their Royal Highnesses the Crown Prince and Princess ; and the delegates were afforded an altogether exceptional opportunity of making themselves acquainted with the position at which forest management has attained in Sweden at the present day. There are points in this management which appear well worthy of consideration by foresters in Great Britain. Whilst portraying, therefore, the efficient management now in force in Sweden an endeavour will be made to indicate directions in which, with suitable modifications, Swedish practices might be adapted to this country. A review of the present methods of management of the forests, interesting as that management, in its varying aspects, is at the present day, would be incomplete without touching upon the other important economic factors they present. I allude to the great value to us and to our industries of the Swedish exports, which reach this country and have been coming to our shores and been absorbed by our industries in ever-increasing amounts during the past 60 years and more.

The total land area of Sweden amounts to 102 million acres, of which 57% consists of forest land, exclusive of marshes, bog land, &c., covered with a more or less scattered tree growth (some of it analagous to the *tundra* of North Russia). The proportion of forest varies in the different parts of the country, to some extent being dependent upon climatic conditions. The country being elongated from north to south the climatic conditions are of a ruder type in the north, and growth, especially tree growth, correspondingly slower. The soils over this large area of forest country are scarcely suited for anything but forestry, consisting chiefly of stony moraine soil and, in certain localities, of fertile calcareous moraines and clays. As at present ascertained, the total forest area amounts to about 58 million acres.

From the forestry point of view Sweden may be divided into three parts, Norrland (north), Svealand (central) and Gotäland (south). The State and other public forests are mainly situated in the north—31% as compared with 13% and 8% respectively in the central and southern parts ; the largest forest owners are the private limited timber companies who own 35% of the forests in the north, 31% in the centre and 9% in the south ; next come the large landlords with 1%, 9% and 11% respectively; lastly, the small landlords, including a large number of farmers owning small forests, with 33%, 47% (in north and central), and the large area of 72% of the forest tracts of the south. The case of these minor private forests or peasants' forests as they have been termed is of very considerable interest and will be dealt with subsequently. From this division in the ownership of the forests it follows as a natural outcome that the forestry work in Norrland and the greater part of Svealand is in the hands of, and is carried out by, the large exploiters, the State and the big timber companies who provide the bulk of

the timber, wood pulp, &c., for export. In the south, forest operations are on a smaller scale, and are connected in the first instance with providing for the requirements of the much denser agricultural population to be found in this region. This does not mean that there is not a considerable area of forest in the south, the figures for area proportions from north to south being roughly 13, 5.7 and 4.9. A large proportion of the latter area consists of young stands, and a knowledge of the large exports which Sweden has sent to this country and elsewhere during the last sixty years provides the reason. For the southern forests had to bear the brunt of the lumbering of the early days, and at that period commercial forestry or lumbering governed the policy of Sweden in order to provide the materials with which to supply her own important iron industry and to capture the European softwood markets.

In addition to the forest area proper, there remain considerable tracts of mountain land and mosses and bogs in Norrland and areas of the latter in Svealand. The forest land areas in Sweden are consequently not regarded as fixed in extent. Whilst the private forest owner is allowed to clear, fell and bring suitable forest lands under agriculture, both the State and private owners are engaged in operations of great importance, and on an increasing scale, with the object of afforesting some of the peat and bog lands in the north and centre. The area of such lands considered suitable to treatment amounts to 3,750,000 acres.

The forest flora of Scandinavia is well known, but it will be necessary to briefly draw attention to certain characteristics. The great Scandinavian timber belt, which stretches from Norway through Sweden, Finland and North Russia into Northern Siberia, consists primarily of conifers, the softwoods comprised by the Scots Pine and European Spruce mixed with Birch and a few other hardwoods. In Sweden the dominating type is pine (*Pinus sylvestris*) and spruce (*Picea excelsa*), occurring either pure or in mixture. The hardwoods in comparison with this dominant type play a much smaller part. At the upper limit of the forest line in the northern mountains the birch (*Betula alba*) occurs, which has merely a protective value. Below and covering a large area of country stretching into Central Sweden the two conifers occur mixed with birch, aspen and alder in smaller and varying amounts, the first-named tree being the commoner. The coniferous forest type stretches into the south of the country but several other hardwoods occur such as oak, beech, lime, elm, maple, ash and so forth. Travelling up from the extreme south, the beech region is passed through, in which the beech and oak form an important characteristic of the forests. Botanically speaking, the boundary between the northern and southern coniferous regions of the country is the northern climatic limit of the oak. Summing up, from the economic point of view, the coniferous species are the chief factor in any consideration of the forests of Sweden, with birch as a species of subsidiary value throughout the country. The growth of the conifers in the north is far slower than in the south, the average coniferous

rotation in the latter being 80 years, whereas it is roughly 160 years in the north.

A factor to which consideration will be given later has an important present-day bearing on the proportion of the pine and spruce in the mixed forests of these two species. The pine is known in forestry as a light-demanding species, the spruce a shade-bearer—in other words, young spruce will stand a greater amount of shade from larger neighbouring trees than pine. Up to comparatively recently the pine had a greater economic value than the spruce. There have been, however, some important changes in connection with markets and exports during the present century.

The sawmill industry still remains the largest consumer of timber in various forms. The most characteristic feature in economic development of recent years, however, is the gigantic expansion of the wood-pulp industry, a factor not without its importance to the press of this country. Sweden occupies at the present day the premier position amongst the sulphite-producing countries in Europe; and its exports of wood-pulp are probably larger than those from any other country. The importance to Sweden of this position is readily perceivable. The wood-pulp industry is the foundation of her paper-making industries, and further, it affords a valuable economic support both to the saw-mill operations in utilising waste, and, even more important, permits of adequate and repeated thinnings being made in the young woods, since the material therefrom is saleable.

Some curious facts have come to light on the subject of the variations in the proportions of the population of Sweden employed in the different industries. A considerable decrease in the numbers employed in agriculture took place between 1870 and 1920, in spite of the area cultivated increasing by 50%. The decrease is attributed to the increased use of machinery in agriculture. The following figures for the populations employed in agriculture, industries and commerce and in the Public Services and professions between 1751 and 1920 are not only of interest, but have some significance for Great Britain. The figures are given for percentage of population: 1. *Agriculture with kindred industries* (forestry, &c.), year 1751, 80%; 1840, 81%; 1870, 72%; 1900, 54%; 1920, 44%. 2. *Industries and Commerce*, year 1751, 10%; 1840, 11%; 1870, 20%; 1900, 39%; 1920, 51%. 3. *Public services and professions and other trades*, year 1751, 10%; 1840, 8%; 1870, 8%; 1900, 7%; 1920, 5%.

The above figures are of interest from a two-fold point of view, if we omit the fact that bureaucracy appears to be on the decline in Sweden. Firstly, fifty-one per cent. of the population is employed in industries, the most important of which are those connected with the forests and their output. Secondly, forty-four per cent. of the people are employed in agriculture and kindred industries, chiefly forestry. Three-fourths of the arable land in Sweden is in the hands of small landlords, and the bulk of the agriculture is carried on by the landowners themselves or the members of the family. This has brought

about the closest connection between agriculture and forestry ; for, as will be shown later, a considerable proportion of the agricultural labour, including the small proprietor of a farm and his family, is employed in the forests for part of the year, especially during the winter lumbering operations.

Before dealing with some interesting sylvicultural aspects of the Swedish forests and developments in extraction and conversion of the forest produce, a brief glance at the historical development of the conservancy of the forests will be necessary.

From an early date the recognition of the value of a forest law made its appearance in Sweden ; for laws of this type existed in the latter half of the sixteenth century. The main basis of these laws, which only applied to parts of the country, was to impose restrictions upon the owners' right to dispose of certain types of forest in their ownership, mainly protection forests.

The real commercial development of the forests took place during the latter half of the 19th century. Throughout this period the commercial interests became more and more powerful, and the efforts which had their origin with Israel Adolf av Strom, who was the founder of the State Forestry Institute (now the State Forestry College), in 1828, and advocated the introduction of scientific conservation methods, were gradually overborne ; for the official classes representing the State to a more or less extent, backed up the timber companies (who had acquired a considerable portion of the more valuable forests, chiefly by purchase from the farmers), in their efforts to obtain a predominating position in the European soft wood markets. To some extent this expansion of the timber and wood-pulp trade had been beneficial, for it had opened up and exploited large tracts of forests which had previously been unexploitable.

The lumbering of the forests, which was proceeding on an enhanced scale year by year, led on the one hand to a revival of interest in systematic and scientific conservation, whilst on the other hand it began to be perceived that the increased exploitation was threatening the future of the forests as a whole. The Government became alarmed at the position which had arisen, and a Committee was appointed in 1896 with instructions to report on the steps to be taken, by way of legislation, to institute some control over private forestry throughout the country. Discussions took place for some years, but it was not till 1903 that a general forest law was enacted which came into force in 1905. The basis of this law was the enactment that the fellings made in forest areas must be replaced by new young crops within a reasonable period. Considerable progress was made under this law, but the outbreak of the Great War led to enhanced demand and greatly increased fellings to take advantage of the extraordinary prices prevailing. To a certain extent, in the interests of the prosperity of the country, some of these extra fellings were justifiable, but they brought to a head the danger facing the forests as a whole and the future of half the trade of the country. Some provisional forest legislation was

passed during this period, chiefly aimed at the protection from felling of the younger age classes in the forests.

The general forest Act of 1905 applied to the whole of the country where there were no special forest laws (chiefly having reference to mountain protection forests and coast forests), in force. The main basis of this Act was to secure satisfactory regeneration of felled areas. Separate bodies termed Forest Conservation Boards were formed, one for each revenue district (county) in all parts of the country subject to the Act. These Forestry Boards consisted of 3 members, one being appointed by the Crown as Chairman, a second by the County Council, and the third by the County Agricultural Society. Each Board had under it a fully trained forest officer termed the County Forester with a number of Assistant Foresters (or Rangers), and Woodmen or overseers under its orders.

In 1924 the total staff under the Boards comprised 34 County Foresters and 205 County Rangers, and 18 Seed Extracting Superintendents, 40 office clerks and a strong staff of woodmen. The Boards were given, each in its county, a remarkably independent position, thus enabling them to adapt their activities to the existing local conditions. They are, in fact, responsible for the enforcement of the provisions of the Act whilst at the same time having the authority to advise and assist in the proper management of all areas of forest within their jurisdiction. The 1905 Act was amended in 1923 by the Forest Conservation Law, which only permits fellings to be made in the younger age classes of the forest in the form of properly marked thinnings. The Boards were also granted powers to prevent fellings for sale purposes being made on such a scale that Estates might not be able to provide for their own timber requirements in the future.

The outcome of these Acts and the enlightened but firm manner of their application carried out by the various Boards, combined with the advice they have tendered, has resulted in a great improvement in forest management throughout the country. Especially has this applied to the small areas of woods some no more than 75 acres in extent, in the ownership of farmers (the farm-forests as they are termed), some of which are reported to be excellently managed.

The money grants made to the Boards to enable them to carry out the duties allotted to them are obtained by a special tax of 1.3 per cent. on the stumpage value of the timber. Perhaps one of the most valuable results of the work of the Boards is to be found in that important matter of selecting the trees for annual or periodical fellings in a wood. It is said that more than half the timber now felled in private woods, more especially in those of the farmer-owners, only takes place after the trees have been selected and marked for felling by the officers of the Boards. It will be evident that the Boards, owing to their composition, have at their back the County Councils and Agricultural Societies of the particular County they represent. The special and varying forestry

conditions of different counties can therefore, within the limits guiding the forest policy for the country as a whole, be given full effect to.

It may be suggested that in the position to which forestry in Great Britain has attained at the present day, the methods to which Sweden has gradually arrived, after passing through a period of grave danger to her forests, merit a careful study and consideration. If we omit for the present the recently formed plantations and Crown forests, the rest of the woods in this country are in private ownership. Many of these are in a poor condition and, owing to changes in ownership occasioned by the heavy death duties and the burdens of the Great War, stand in a perilous position. To the forester the position of these woods, occupying a forest soil which, however impoverished, offers greater possibilities than the afforestation of bare lands, must be fraught with the gravest anxiety. Controversies in the press have shown how varying are the conditions in the different counties, both in connection with the maintenance of existing woods and in obtaining and planting up bare lands. It appears not impossible that the inauguration of forestry in Great Britain, and that difficult matter of arousing the interest of the public in this important question might progress with greater rapidity and a minimum of friction if the lines upon which County forestry has been improved in Sweden were carefully studied with the object of making a trial in Great Britain of such as were suitable.

The Swedish Forest Acts have not had the same importance to the management of the larger privately owned forests. Here, as in the case of the State forests, owing to the large capital involved, the introduction of a more rational management combined with the regeneration of cut areas had made its appearance in the early years of the present century. The expenditure so incurred has been necessitated if the concerns are to be kept on a working basis, so far as the provision of the raw material for the mills, &c., is concerned; it has also been rendered possible by the improved facilities for marketing the smaller classes of timber, particularly for wood-pulp. The research work which has been instituted both by the State and some of the larger timber companies has also led to better management in the forest and improved methods of exploitation, combined with the employment of men trained in the science of forestry. In other words, there has come about a close association between the practical commercial timber man and his scientifically trained forest confrère; and it is admitted on either side that both have gained enormously through the association.

An important economic factor already alluded to has necessitated a reconsideration of the degree of commercial importance of the chief species of the Swedish forests. Up to comparatively recently, the Scots Pine was the most valuable species since it provided the best-priced material for the sawmills. It had therefore been favoured from the sylvicultural point of view in regeneration work at the expense of the spruce, both in naturally regenerated areas and for new afforestation work. Owing to the enormous development of the wood-

pulp industry, spruce is now in greater demand, and, further, in Southern Sweden the spruce produces a larger volume to the acre. The spruce is, therefore, where locality factors are suitable, economically the most profitable crop to grow at the present day.

Another development is in connection with the birch previously regarded, owing to its encroachments in the coniferous forest, as a forest weed, as is so often the case in Great Britain. Investigations which have been carried out in connection with forest soils have proved, for Sweden at least, that birch has a very favourable influence on the improvement of the soil factors, a quality which is now regarded as of high value, especially in the soils of Norrland where there is so much raw humus. As will be shown subsequently, birch has by no means so useful a role in the south. Here it has taken possession of considerable tracts felled in the seventies and eighties of last century at the expense of the conifers which should be occupying the area.

It has been already shown that the supervision of the forests and of forestry work generally in the revenue districts is under the Forest Conservation Boards. The management of the State Forests is under a different Authority, the Forest Service Board with Headquarters at Stockholm. These forests comprise 13 Inspection Areas with 140 districts divided into 625 ranges ; the area of the district varies with the importance and intensity of management of its forests. The seven most northerly inspection areas include nine-tenths of the State Forests. The State Service also manages the municipal and other public forests and the ecclesiastical forests. It also controls the management of the forest areas in the north which are under the special laws. The State forests are all under Working Plans, the calculated annual possibility or yield under these plans requiring the sanction of the headquarters Board. Rates and taxes are paid on the State Forests.

It is now proposed to glance at some of the sylvicultural aspects in the management of the forests. We may start from the general proposition that the aim of every Swedish forester is to obtain his new crop of young trees, after felling the mature one, by means of natural regeneration. For many reasons, this is not, at present, always possible and artificial work by sowing seed or planting has to be resorted to.

For the purposes of the sylvicultural treatment in force Sweden may be divided into two parts. On the large forest estates in the southern portion (i.e., South of the River Dalalven), the forests were either clear felled and regenerated artificially or treated under a shelter wood compartment method, under which a percentage of the trees are left standing over the area to provide seed for the development of the new crop. The clear fellings were often made over excessively large tracts, and the subsequent artificial regeneration work was said to have been done with seed or plants of doubtful origin and unsuitable to the locality. It is probable also that the inclement climate and excessive exposure exerted a considerable influence on the poor results attained. This

has now become recognised, and where clear felling is still resorted to the areas felled in any one spot are greatly restricted in size, in order that they may become regenerated either naturally by seed blown on to the area from the adjoining standing forest or by direct sowing, the ground where necessary being cultivated with a plough or other means. The expensive method of planting with nursery raised plants, practically the only method at present in force in Great Britain, is only adopted when the far cheaper methods are impracticable. When the new crop is obtained by leaving seed trees standing on the area the number so left is greater and follows the practice in other European countries where this method is well understood. Moreover, the increased value of the spruce, which stands more shade than the pine, has facilitated the introduction of the well known Continental methods, with suitable modifications such as the French modern *jardinage* and Gayer's and Wagner's strip methods, the latter still under trial. Artificial work is now greatly restricted and when adopted perforce is rendered as cheap as possible by labour-saving devices, strict attention being paid to the origin of the seed (chiefly used), or plants.

In Norrland in the North with the exception of the coastal districts and the lower portions of the large river valleys, where forest conditions approximate more nearly to the part of the country dealt with above, the position is very different. Here there exist large tracts of overripe forest producing but little increment. These forests are situated in the upper and interior parts of this northern region covering large areas. The problem before the forester, chiefly the State forester (for these are mainly State forests), is how to convert this forest type into a more profitable one. Research work on a considerable scale has been instituted with the object of endeavouring to solve this problem, So far the investigations tend to show that the seed of the pine of those regions possesses in certain years very little or no germinating power ; that artificial work with pine in past years has usually been a failure ; and that the chief cause of failure in the present condition of the forests must be looked for in the condition of the humus layer which, under the extremely bleak climatic conditions, undergoes little change, and may be characterised as a bad type of raw humus. Consequently the experiments now being conducted have relation to different types of felling made with the object of ascertaining the best way to bring about the decomposition of this raw humus layer ; to break up, in other words, the stagnant condition of the forest soil by promoting activity. It is recognised that once this condition has been brought about, artificial regeneration work will have to be resorted to. A point of great interest and importance which has come out of these investigations, in the words of the Swedish writer, is the following :—" That pine " (he is writing of the seed in the north) " is extremely susceptible to removal from one climatic area to another, even if the difference in temperature is very slight."

It is said that from 15 to 20 per cent. only of the areas felled annually are artificially regenerated either by direct sowing or planting ; the remainder being naturally regenerated.

The thinning of the woods now in force in Sweden is on a far higher plane than formerly. This has been greatly assisted by the demand for smaller dimensions of trees, especially for wood pulp. The demand for pitwood for the British collieries has, of course, existed for a long period. The average period of repetition of thinnings in the forest is now 10 years, but it is considered that under some conditions the period might be reduced to 5 years.

Even in the comparatively new work of afforesting the bare heaths and so forth, Sweden is paying particular attention to costs. Since a considerable part of this work is being undertaken by the trained expert foresters employed by the large companies, the fact that expenses are kept down and direct sowing is preferred where practicable to the more expensive formation by planting out plants raised in nurseries is understandable.

We find then that the work of creating new forests on the considerable areas of heaths and marsh and boggy ground forms no unimportant part of the forestry business in the country. This work is being mainly carried out by the State Forest Service and the large timber companies, but smaller proprietors are following the example thus set. The drainage of swampy forest ground, in order to obtain a good forest crop, has greatly attracted the interest of the smaller proprietors. The correct method of laying out and cutting forest drains and ditches has been brought to a high art during the last twenty years. Something over 3,000 miles of forest drains were cut throughout the country in 1925—a considerable portion by the big timber companies. Exotics are being used to some extent, but the work is chiefly confined to spruce and pine.

In connection with our afforestation programme in Great Britain, a point which it would appear requires serious consideration is the cheapening of the present high cost in formation of the plantations. The idea of formation by direct sowing has received but scant recognition by those responsible in this country. And yet we find it forming the main basis of similar work here in Sweden, and the same is the case in France where large areas in Auvergne and neighbouring districts of very similar a type to many existing in Great Britain are being afforested. France would certainly never face the expenditure (even when the extra cost of netting against rabbits is deducted) which we are incurring per acre of new plantation formed at the present time ; and a study of the position in Sweden gives evidence of the same condition of affairs.

As has been shown, the large landed proprietors own but a small percentage of the forests. But these forests have been managed on scientific principles for a long period of years, and some of the best forests, the "show" forests of Sweden, belong to the large landlords. It was this small body who first introduced a rational form of forest pasturage, which in the past has proved so destructive to the forests.

There remain for consideration the farm-forests and their management. It is here that the Forest Conservation Boards have done such good work. In the main they consist of small woods dotted about the country-side ; the State

forests, as a matter of fact, include a not inconsiderable number of the same size and type. These farm-forests are of very ancient origin, although till recently their management was on primitive lines and the pasturage to which they were subject was often excessive. The area of a forest of this type, on an average for the whole country, amounts to about 75 acres. The larger ones yield timber, apart from the owner's requirements, for sale, the buyers being the big timber companies who have to purchase in the market to enable their sawmills to be kept running full time. Under the Forest Conservation Boards, the improvement in the management of the farm-forests has made greater strides with the big farm-forest owners than the smaller ones. The thinnings and major fellings are marked by the forest staff of the Boards, working plans are prepared and advice given on all general details of management. It is held, however, that taking into consideration the period the Boards have been at work, the improvement in the management and the interest taken by the owners in the farm-forests as a whole has resulted in an advance which may be expected to increase yearly.

The farm-forests of Sweden and their method of management present, to my view, a problem of absorbing interest. As a result of death duties and the War, the break-up of large estates in Great Britain has resulted in the tenant farmers in many counties, especially in England, becoming the owners of their farms, and in many cases of the small woods standing within the perimeter of the farm lands purchased. The bulk of these woods are of broad-leaved species, oak, ash, elm, chestnut and so forth. These timbers have always had a value in this country both for structural and the finer cabinet, etc., work; and also to the people on the countryside. The Forestry Commission have not, as yet, shown little interest in these woodlands. Their present owners either have not the money or the knowledge to maintain them under a scientific management. And yet it is unthinkable that the public would witness their disappearance with any pleasure; yet without careful attention many of them are doomed.

Both in Sweden and in France and elsewhere in Europe methods have been introduced by which the efficient management of similarly owned woods has been made practicable, the continuance of their produce and the amenity and shelter they afford being thus assured to the population in their vicinity. It may be suggested that a study of these methods should enable us to find a way to preserve and make pay (or at the least cover the expenses of upkeep), the many beautiful woodlands scattered throughout the counties of this country. With the new position brought about in land ownership, this matter may be regarded as one of some urgency if forestry, as apart from mere afforestation work on bare lands, is to take its true position in the country. To those interested in this matter a study of the Swedish methods introduced during the last twenty years should prove of considerable interest.

There remains for consideration, in connection with the Swedish forests, the practical factors relating to the amounts of available materials in the forests,

and the exports of produce, in both of which Great Britain has a considerable interest. It has been shown that in the interior of Norrland as also in Svealand, there are large areas of mature and over-mature timber. These forests are being exploited, and since the increment is deficient the annual fellings necessarily exceed the increment being put on. In the bulk of the finer forest areas it is held that the age classes are more normal; though here again, in view of the large fellings, often clear fellings over considerable areas, made by the big timber companies in the latter half of the nineteenth century, which areas it was found difficult to regenerate, it is probable that in certain tracts the younger age classes are in excess. In southern Sweden there is a shortage of the old age classes, owing to the heavy fellings of 30-40 years ago; consequently in this region there are large areas of young forest in considerable portions, of which birch is predominant amongst the conifers.

These factors were well known, and with the object of obtaining statistics on the relation between growth and cutting, the Riksdag made a grant for a general survey of all the forests of Sweden. The survey was carried out by well known experts, and at the end of 1927 89% of the forests had been examined and reliable data obtained from the various districts. It is not considered that the survey of the remaining 11% will alter the figures acquired. Briefly, the results show that on the 51,000,000 acres of good average forest soil so far investigated, there are 1,480,000,000 cubic metres of growing wood (measured over bark), not including hardwoods of less than 5 centimetre diameter at breast height. The cubic contents amount to 1,025 cubic feet per acre, of which 83.5% are softwoods and the balance hardwoods. The total annual increment is calculated at approximately 50,000,000 cubic metres or about 30 cubic feet per acre. The distribution of the age classes throughout the whole country is as follows:—Blanks, 7%; 1-40 years, 23.7%; 41-80 years, 34.1%; 81-120 years, 15.1%; 121-160 years, 9%; over 160 years, 11.1%.

The volume of timber, as also the annual increment, is smaller than that of former calculations. But there is a better distribution of the age classes from which a permanent annual yield may be obtained than was anticipated. It is held, therefore, that it does not appear probable that Sweden will have to reduce her exports of forest produce generally, although both the amounts coming from different parts of the country may change, as also "the different groups of manufactures," an allusion, perhaps, to the fact that wood-pulp will displace timber in bulk of exports. It is also contended that, taking volume alone, the annual cut does not exceed the increment. It is admitted, however, that timber cutting is carried out on a large scale in the more favourably situated forests, whereas the increment being put on in the young woods will only be available for use (as timber) in the future.

Apart from the State, and more important, the big Companies take a prominent place in Swedish forest activities. There are some 160 joint stock companies owning forests, the largest one in possession of a company amounting

to 750,000 acres of good forest soil. In these concerns forestry is combined with timber, pulp and iron industrial enterprises. Wood-working industries, including that important one, the match-making industry, also own forests. It is to these industries that the surplus produce from the farm-forests is sold. The larger forests owned by companies are in charge of fully trained foresters and are managed on lines similar to the State forests, the yearly fellings and thinnings being carefully marked by the trained officer. The latter is now-a-days, as we have seen, undertaking the work of afforesting, where possible, the waste marshy, etc., lands of the company's property which were formerly left neglected.

It is of interest to mention that the forest lands owned by the larger Companies were chiefly acquired after the middle of last century by buying the forests owned by farmers. Legislation has now put an end to this method of acquisition which, in most countries, is an unsound mode of land ownership.

Felling in the forest and extraction work to the conversion or exporting centres presents few difficulties in a country such as Sweden, where water facilities in the north and centre are abundant. Labour, mostly domiciled on farms in the vicinity of the forest, is abundant, and the farmers and their employees are conversant with forest work. The farmers bring their own horses with them when working in the forest. In the case of the State and large forests owned by Companies, a permanent staff is maintained throughout the year (supplemented when required), who occupy small tenant farms (small holdings), situated throughout the forests. Felling and transportation in the forests is paid by piece-work. In the northern and central parts of the country snow facilitates the transport of the timber to the waterways, and floating is the chief method of transport. In the south snow is less abundant, and waterways are scarcer. Forest produce is, therefore, taken by road to the railways and at times by canal. The length of the waterways used for floating purposes amounted to 19,000 miles in 1927, about 450,000,000 solid cubic feet of timber being extracted by this means. The annual cost of floating this material amounted to 26,000,000 Kr. (approximately £1,450,000), or about one-seventh of the cost by railway for the same distance at existing rates. The distance from the forest to the waterways varies from 1-4 miles only.

It must not be imagined, however, that these waterways were all naturally suitable channels for timber flotation. As a contrast to conditions in Norway, the gradient from the mountains to the low lying levels and the coast is comparatively gradual in Sweden and this facilitated improvement work. Large sums were devoted to the amelioration of the river and stream beds by blasting the rocks and so forth to enable the timber to be sent down with a minimum waste of time from the forest to the conversion and exporting centre and the minimum amount of waste from rock-breaking, &c. The presence of numerous large lakes also assists the floating by prolonging the period of high water due to the melting of the snows in the spring. In the words of a Swedish

writer, the position is summed up as follows :—" On the whole it may be said that a plentiful supply of timber of a high quality, a good demand from countries well situated from a transport point of view, a population well adapted for industrial requirements, and excellent transport channels, are the conditions upon which the export of forest products, which has been of such uncommon importance for the country's economy, has been able to rely."

And, from the point of view of the professional forester, a very excellent and unusual combination of conditions they are, even with the recognition that Sweden, by a bold expenditure in the past, has enhanced their natural value.

The chief factor governing Sweden's large export trade in forest produce is to be found in the fact that there are about ten acres of forest and eight cubic metres of annual growth per head of population. It is for this reason that so weighty a proportion of Swedish industries are based on the forests and their produce. The value of the exports of pulp, paper, &c., rose from £19,400,000 to £22,800,000 between 1924 and 1926, whilst wood goods of all kinds decreased from £15,900,000 to £14,300,000 during the same period.

In the case of Europe, Sweden at present holds the premier place as an exporter of soft woods, both in amount and in the high grade of its products as placed on the markets. Of these exports Great Britain took 41 per cent. in 1927 as against 32 per cent. in 1913.

The great asset to the country is the amount of conversion of the raw product which is undertaken in the numerous sawmills situated either (and chiefly) along the coast of Norrland at the mouths of the chief rivers, or on the many lakes of the country. Most of these mills, some of which are of long standing, have been brought up to date so far as machinery, etc., goes. They used to be run by steam power consuming the waste of the mill. Latterly, however, electric power (from water) is supplanting the old method, since much of the waste can now be used for pulp wood. An average Swedish export sawmill has an annual output of 7,000 to 10,000 standards (1 standard—1,980ft. board measure), but the largest have an output of from 30,000 to 35,000 standards. The produce is converted into deals, battens, boards, staves, box materials, laths, mouldings, &c., a normal annual export of these materials amounting to approximately 1,000,000 standards.

Perhaps the factors which stand out most clearly from this review are, firstly, the belief that there will be no falling off of the exports, though so far as Great Britain is concerned, it appears as if there may be a drop in the larger timber sizes in a comparatively near future; secondly, that a good conservative management is now in force throughout the country, under which there is every hope of introducing an effective management even into the smallest of the forest areas owned by the peasant farmers; thirdly, and most significant, that the Company forest owners have realised that serious attention has to be paid to the regeneration and the correct thinning of their forest areas if they wish to maintain them in perpetuity as commercial forest propositions.

Lastly, Swedish forest officers, timber merchants and Government alike, have recognised that if the output of the large forest area, upon which the life of the country and the livelihood of so large a proportion of the population depends, is to be maintained or increased, research work must be encouraged. Sweden's position as regards research in forestry is quite different from that of Great Britain, and she is justified in devoting considerable sums of money to this matter. She has a large area of forest in existence, her Government derive a certain income from the State forests, and a considerable number of important timber companies have a large capital invested in forest property. With the object of safeguarding this capital both Government and the large timber companies are annually making grants towards research. The Research Institute in connection with the State Forestry College, situated on the outskirts of Stockholm, is supplemented by research centres maintained by some of the large timber companies on their own forestry estates. Research work is thus decentralised on rational lines.

The various bodies interested in Forestry in its various aspects in Sweden, find a common meeting place in the Swedish Forestry Association, founded 25 years ago. It is held that this Society, as much as anything else, has brought together the landowner, the trained forester and the timber company representatives and has enabled the views held by each to be pooled and discussed, thus leading to a common recognition of the place each holds in the forestry firmament. That such a recognition exists is unquestioned. It is held that it is largely due to the activities and energy of the present Chairman of both the College and the Association, that remarkable man Admiral Arvid Lindman, the present Prime Minister of Sweden.

In conclusion, and at the risk of repetition, I would offer the suggestion that a study of Forestry management in Sweden at the present day offers several points meriting consideration by foresters in Great Britain.

Two of major importance. The first, that experiments should be made on a considerable scale, and be persisted in, with the object of forming plantations by direct sowing on suitably selected areas instead of the costly plantings. And second, we have in existence nearly 3,000,000 acres of woods in this country, and the Census, recently published by the Forestry Commission, has shown us roughly the composition and condition of these woodlands. The remarks upon these woodlands which have appeared in Annual Reports by the Commissioners would appear to show that they attach but a small value to much of this area; that in fact, they appear to view its disappearance, so far as a considerable portion of the hardwoods at least are concerned, with equanimity, or where conditions are favourable their replacement by conifers. Now one part of the forest capital consists of the soil, and this considerable area of woodlands covers a forest soil which, however depreciated by poor management, at least forms, it may be suggested, a more valuable item of forestry capital than that comprised in lands which have not carried crops of trees for a long period of

years. A study of the methods by which the County Forest Conservation Boards in Sweden are safeguarding and improving the large numbers of small woods in that country, should point a way by which we might solve the question in this country, and thereby save from disappearance a large proportion of the beautiful woods of oak, elm, ash and so forth which form a feature of the English countryside.

In conclusion, I should like to express here a sense of my great indebtedness to the Officers of the Swedish Forest Service and others for the kindly assistance accorded to us all in Stockholm during the Centenary celebrations. If a clear view of the position of Swedish forestry to-day has been made possible for the foreigner it is due to their efforts. To Professor Tor Jonson, Dean of the Forestry College, our thanks are due for the beautiful forest views with which the lecture has been illustrated; for he took great trouble in selecting the photographs from which the slides were made.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said they had listened to a most interesting lecture, and he thought it would be agreed that the emphasis which Professor Stebbing had put on the importance to England of the administration of the Swedish forests was quite justified. As had already been shown, the produce of Swedish forests was of such importance to the people of these islands that the more this was realised the more anxious must they desire to cultivate the best relations between the two countries. "Wood comes first," was a saying that used to exist in the timber trade, and he wished to apply it in that connection. He thought that British requirements for spars, boards, tar, and the various kinds of forest produce, constituted possibly the earliest big trade with Sweden. For some time Great Britain was vitally dependent on the Swedish forests, and that was the case with all the northern European Powers which obtained the control of the sea. The Hanseatic League was brought to agreement with Sweden in order to get timber; when Holland succeeded to the position of the leading sea power, she had the same experience; and when England rose above the horizon of the sea the same thing was repeated. He noted, for instance, that Townshend in 1715 wrote a letter to the King complaining that if the Admiralty was barred from acquiring the necessary stock of forest produce from Sweden then "it would be impossible for his Majesty to fit out any ships for next year, and the whole navy of England would be perfectly useless." That statement seemed to give some evidence of Sweden having, unknowingly, taken a part in the building of the British Empire and the maintenance of the English fleet. At the present time statistical tables bore out the extent to which this country in other respects was dependent on the forests of Sweden. British imports from Sweden in per cent. of total imports were as follows:—Printing and wrapping paper, in 1913, 22.8 per cent.; in 1927, 24.6 per cent.; wood pulp, in 1913, 38.6 per cent.; in 1927, 36 per cent.; soft wood (hewn and sawn), in 1913, 17.8 per cent.; in 1927, 14.9 per cent.; planed or dressed timber, in 1913, 60.8 per cent.; in 1927, 61.5 per cent.; pit props, in 1913, 11.3 per cent.; in 1927, 11.5 per cent. Those figures showed a constant progresssion of imports from Sweden, which was the more remarkable as the total imports of

those materials into England from all countries had greatly increased between 1913 and 1927, the increase in paper being 27 per cent., in wood pulp 49 per cent., and in wood and timber 16 per cent. It was of great interest to know that the Swedish forests would not be exhausted. As a matter of fact, the reverse was happening. They were increasing both in value and in area. They were better cultivated, and the population took a great part in the planting of the moors and the more or less barren land with seeds to grow new forests. Even the school children were encouraged to take a part in the national campaign for afforestation. During the last thirty years Sweden had awakened the national consciousness in this respect. After the able lecture to which they had listened, it was not necessary for him to enlarge upon the subject, but he wished to say that, just as an Englishman loved the tree, so the Swede loved the forest; and forests covered 57 per cent. of the land, *i.e.*, an area double the size of England and Wales. It was quite remarkable to note that the best cultivated forests were in the hands of the Government and the companies—in all, 45 per cent. of the entire country, of which 16 per cent. was State forest. They could thus feel quite sure that the British market had a steady and permanent supply of the important raw material represented in Sweden's forests. With the increasing demand for timber, sulphite and pulp in the world that was a factor which ought to be taken into consideration. He was very pleased that the lecture had been given, and that it had been listened to with such great attention. It was a sign that the people on this side of the North Sea realised the great and growing interests they had in common with the people of Sweden, and which, he was convinced, would not cease to exist.

MAJOR JOHN COSGROVE, D.S.O., M.C. (Forest Products Research Laboratory) said they had listened with very great interest to Professor Stebbing, and he was particularly interested to hear about the splendid sylvicultural work in Sweden. In England and in other parts of the British Empire they were often confronted with the problem of growing timber suitable for marketing, and some of the pictures shown on the screen that evening indicated why Swedish timber was capable of finding a ready market in this country and of being so popular. They noticed that the trees were particularly straight and that the boles were well formed, so that the resulting timber would be straight grained and capable of good manufacture. He thought that that little lesson in itself was very important, and one which should be kept in mind in England, particularly in view of the fact that we were now investing largely in afforestation work. In different parts of the Empire they were also obliged to give consideration to that question. He was also interested to see some of the methods of transportation, which were cheap, and of course, peculiar to the country, and the very economical manner in which the Swedes carried out their work. The cleanness of the felling seen in the pictures indicated careful attention and true economy, which were laudable aspects of Swedish work.

MR. F. PARKER SMITH said that as a paper maker he had been very interested in the lecture. In 1910 he had the honour of being asked to read a paper to the Papermakers' Association on the question of pulp, and he then went into the matter of Swedish supplies and also those of other European countries and Canada in relation to what could be done in this country. He would like to draw attention to one point. In 1910, they found from the reports of Professor Schlich that the actual consumption of timber in Sweden was then exceeding the growth by about 100,000,000 cubic feet; and the last report showed that it was practically 350,000,000 cubic feet in excess, but there were indications, from the progress that

was being made in Sweden in encouraging growth, that it was possible to get the normal production of timber in Sweden increased by 50 per cent. This showed what a very large margin of increase was possible with care. When one came to consider our own country in the light of Sweden, there were some 12,000,000 acres in England which were suitable for growing timber, and if this area was under timber, it would be posible, after paying all expenses, interest charges, labour, and the original cost of seeding, etc., to leave a profit of at least £1 an acre per annum during the whole period of 60 or 90 years' growth of the trees. This was a very important item because an increase in sylviculture would result in the establishment of other businesses which were ancillary to sylviculture and which would be of enormous benefit to the country.

It was estimated in 1910 that 11,000,000 acres would provide Great Britain with all the soft wood she imported either in pulp or in paper. It took, roughly speaking, 25,000 acres of timber to supply a continual growth of wood for 100 tons of paper per week. In England, while there was a good deal to be said for the small timber holdings, it was feared that the small beautiful woods which we saw might disappear, and the only way to overcome that was to copy the Continental method whereby a local Board laid it down that at least three trees should be supplied for every one cut down. The only way to attempt afforestation in this country was to take a whole watershed and plant that under the most approved methods, look after it thoroughly, and then pass on to another watershed and control that. Some time ago he drew up a chart as to what it would cost to plant 150,000 acres per annum. At the time he was able to show by the figures given that every eighty years there would be, he thought, a profit of £100,000,000! That was an actual fact, but in connection with such large figures it was no use the matter being attempted by private persons. It must be done by Government action. One of the difficulties they were up against was that as soon as they planted anything, rates had to be paid, and that if anybody planted a forest, there were at least two death duties in the life of that forest. These were some of the difficulties that had to be faced. It was necessary to recognise that land existed in England which could supply an enormous amount of timber, but which was going to waste increasingly every year.

PROFESSOR FRASER STORY referred to one or two points which impressed him during the lecture. He absolutely agreed with Professor Stebbing that what had been done in Sweden should encourage us to improve our methods in England; and he ventured to go farther and say that Sweden set a good example not only to Great Britain but to the whole of the British Empire. It was conserving its forests and regulating its fellings according to its annual growth in a manner that was not done in many parts of the Empire. There were a few remarks of Professor Stebbing, more especially in regard to the operations of the Forestry Commission, with which he could not quite agree. For example, the lecturer said in regard to direct sowing that this had received scant attention on the part of the Commission. He (the speaker) thought that was scarcely correct. It was true that they had not sown very large areas, but they were very much alive to the possibilities of that means of forming plantations. There was present that evening one of the officers who had been particularly active in advocating direct sowing in order to establish plantations. It was true that they were doing that more in England and Wales than in Scotland, and Professor Stebbing might have received his impression from the northern part of the country.

He thought that it must always be remembered that conditions in Sweden were really very different from those obtaining in Great Britain. It certainly was

true that they could, as it were, receive inspiration from the study of forestry in such a country, but it was only after the most careful investigation that they should adopt methods which were new from a country whose climate, soil and other conditions differed very considerably from our own. For example, there was the matter of natural regeneration. In Sweden they had a country which was under snow for many months of the year. The small seeds of the pine, spruce and other trees fell on to the snow, and were brought with the melting snow into the soil on the arrival of spring ; there was a much more rapid transition from winter conditions to summer conditions in Sweden than in this country ; the seeds germinated quickly and there was less growth of grass and weeds than we had ; in addition they had not the pest of rabbits. He did not hear any reference to rabbits in Professor Stebbing's address! These conditions made natural regeneration easier in Sweden and also in Finland. Moreover, we had not many fine old conifer forests to restock as in Sweden. The operations of the Forestry Commission had to be carried out almost entirely on bare land. It was only right that, where there were standing forests in private hands, they should continue under private enterprise rather than that large sums of money should be spent merely in the taking over of these forests by the State. Rather should they afforest afresh the bare land, and in order to do this they must obviously adopt some artificial method of sowing or planting.

Mr. W. L. Taylor said that to anyone interested in forestry in this country Mr. Stebbing's lecture had been extremely interesting, for it was necessary that one should know what was going on in European countries, especially Sweden, where forestry had been a science for so many years. With regard to direct sowing, the position was rather as Professor Stebbing had just said. The Forestry Commission were stocking poor land - some of the poorest in this country. They knew that they could stock that land by planting, but they did not know with certainty that they could establish plantations by direct sowing. Direct sowing, however, had been done in Suffolk, in Dorset, on the hills in South Wales and in Devonshire for the last seven years—a small amount each year because there had been no money available for heavy expenditure in that way, so largely experimental. The work had shown promise, and he hoped that the method of direct sowing would be extended in this country year by year, as they got more experience.

Dr. Rushton Parker remarked that Professor Stebbing had said nothing about disease in Sweden. He would like to know whether Sweden was fortunate enough to have no signs of disease in trees.

Professor Stebbing, replying first of all to the last speaker, mentioned that Stockholm had not yet finished with its invitations to forestry countries and others interested, and next year it was going to have a conference on research work. Consequently, they might expect to hear a great deal about the research work which was being undertaken in Sweden, and, therefore, about disease in trees. He did not know that he could offer any remarks upon diseases and pests which might, or might not, exist in Sweden. As regarded the other speakers, he did not think he could enter that night into arguments on what were rather technical forestry subjects but he thought it was rather doubtful whether they could plant as much as 12,000,000 acres of land in this country to produce forest which would pay during the first rotation, or even possibly during the second rotation. A certain proportion of that area at the present moment was situated at an elevation beyond which it would not be practicable or profitable to plant until the lower areas had been

placed under tree crops. He fully agreed that it would be advisable to institute some method by which, when trees were felled in the small woods of the country, arrangements could be made for replacing them with young growth. In regard to the question of sowing, he thought Professor Story must have misunderstood some of his remarks. He would not for a moment imply that they should take over any existing woodlands. Far from it. He had simply drawn attention to the fact that in other European countries the Government Forest Departments had found methods under which small areas of privately-owned woods could be efficiently managed. So far as rabbits were concerned, they had to keep these out by means of fences and netting whether they planted or sowed up the areas. In regard to the amount of work done—he knew Mr. Taylor had done exceedingly good work in direct sowing—they had to depend upon the reports of the Forestry Commission. They would there find that the greater part of their energies had been devoted to afforestation by means of the nursery and young plants. He was not going to say they were wrong, but it seemed to him that the Forestry Commission should make efforts on a larger scale with direct sowing in order to cheapen first costs. Our climate was better than that of Sweden, and we had all the conditions in favour of making a start in the study of this question of direct sowing.

In conclusion, Professor Stebbing said he would like to propose a vote of thanks to his Excellency the Swedish Minister for presiding, and he personally thanked him for his exceedingly interesting remarks in connection with Sweden, her forests and their utility to Great Britain.

The Chairman, in reply, referred to the progress that was being made in Sweden in the growth of timber in relation to consumption. It was difficult to give an exact calculation, but year by year the calculations showed better results. He was glad to propose a vote of thanks to the lecturer, who, he was pleased to note, appreciated that there was something to learn from Sweden. Lectures of the kind given that evening and their discussion were the means of promoting understanding, of encouraging friendship and of keeping contact.

The vote of thanks having been carried unanimously, the meeting terminated.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

December 12.—G. G. Blake, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice." Sir Oliver J. Lodge, M.A., LL.D., D.Sc., F.R.S., will preside.

January 16.—Professor Charles R. Darling, A.R.C.Sc.I., F.I.C. "The Domestic Smoke Problem—Practical Solution."

January 23.—Sir Henry A. Miers, F.R.S., "Museums and Education." The Right Hon. the Earl of Crawford and Balcarres, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

January 30.—George Fletcher, "The Shannon Scheme and its Economic Consequences."

FEBRUARY 6.—SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture).

FEBRUARY 13.—CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms and their Insect Visitors."

FEBRUARY 27.—A. F. SUTER, "Resins."

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., "Modern English Architecture."

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced:—

JAMES MORTON (of Morton Sundour Fabrics, Ltd.), "History of the Development of Fast-Dyeing and Dyes."

SIR GERALD BELLHOUSE, C.B.E., H.M. Chief Inspector of Factories, Home Office, "Safety in Factories."

J. F. CROWLEY, D.Sc., B.A., M.I.E.E., "Recent Developments in Vegetable Oil Extraction."

MAJOR T. H. BISHOP, M.R.C.S., L.R.C.P., D.P.H., "The Purification of Water."

LADY INGLEFIELD, "Lace."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

FEBRUARY 8.—CAPTAIN E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., "The History of the Indian Marine."

MARCH 8.—W. H. MORELAND, C.S.I., C.I.E., "The Report of the Royal Commission on Indian Agriculture from the Historical Standpoint."

APRIL 12.—A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

MAY 10.—P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture).

DOMINIONS AND COLONIES SECTION.

At 4.30 o'clock.

FRIDAY, DECEMBER 14.—THE RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D., "The Improvement of Negro Agriculture." DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.R.S., F.L.S., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Ind.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." Three Lectures: January 21, 28 and February 4.

LECTURE I.—THE USE OF COAL IN ITS RAW STATE. Historical introduction—Production and distribution—Sampling and analysis—Efficiency of utilisation—Steam raising—Pulverised fuel—Furnaces and process work—Domestic heat production.

LECTURE II.—HIGH TEMPERATURE CARBONISATION PROCESSES AND COKE TREATMENT.—Gas manufacture—Purification, blending and sizing—Steaming—Oil injection—Total gasification.

LECTURE III.—LOW TEMPERATURE CARBONISATION—LIQUEFACTION OF COAL.—Low temperature carbonisation—Internal and External heating—Hydrogenation process—Synthetic processes—Combustion of oil.

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic Movements in Asia." Four Lectures: April 15, 22, 29, and May 6.

SHAW LECTURES.

Monday evenings, at 8 o'clock.

SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories 1898-1927, "Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4.

LECTURE I.—The "Looks" of the People.

LECTURE II.—Twenty-five Years' Experience of the Notification of Industrial Diseases.

LECTURE III.—Twenty Years' Experience of Compensation for Industrial Diseases.

DR. MANN JUVENILE LECTURES.

Thursday afternoons, at 3 o'clock.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, "Ships and Lighthouses." (Illustrated by lantern slides). January 3 and 10.

Special tickets are required for these lectures.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 10..Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Major C. G. Nevatt, "Experiments on Self-Energised Brakes."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.45 p.m. Mr. A. Chaston Chapman, "The Chemistry of Hop Oil."

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr. F. L. Brayne, "Village Uplift in India."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. E. W. Dorey, "Power Factor Tariffs and Methods of Metering."
At the University, Liverpool. 7 p.m. Mr. E. H. Shaughnessy, "Transatlantic Radio-Telephony."
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

Farmers' Club, at the Whitehall Rooms, S.W. 5 p.m. Sir William S. Haldane, "Can British Farms compete in Meat Production against Imports from Abroad."

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Two papers on "Fuels—Alternative or Supplementary to Petrol—for use in Internal Combustion Engines for Road Vehicles"—(1) Dr. W. R. Ormandy, "Liquid Fuels". (2) Monsieur A. Métral, "Gaseous Fuels."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Messrs. S. W. Boggs, A. R. Hinks, and others, "New Map Projections."

Heating and Ventilating Engineers, Institution of, at the Borough Polytechnic, Southwark, S.E. 7.30 p.m. Mr. E. T. Ollett, "Air Filtration."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. F. Hudson, "Scottish Moulding

Sands and their Application to Non-Ferrous Casting."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. F. G. Fleury, "The recent Rating Acts in Operation."

University of London, at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen. Sir Frederick Maurice, "Allenby's Campaigns in Palestine." (Lecture I).
At the Royal College of Surgeons, Lincoln's Inn Fields, W.C. 4 p.m. Mr. F. W. Twort, "The Rôle of Bacteria in Nature." (Lecture IV).
At University College, Gower Street, W.C. 5.30 p.m. Lieut.-Comdr. A. S. Elwell Sutton, "The Republic in China: Its Rise, Progress and Prospects."

TUESDAY, DECEMBER 11..Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. Mr. Harold Bowen, "Notes on Early Muhammadan Titles."

Automobile Engineers, Institution of, at the Broadgate Café, Coventry. 7.30 p.m. Major C. G. Nevatt, "Experiments on Self-Energised Brakes."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. W. W. E. French, "Short Circuits in Large Power Systems."
At the Engineer's Club, Manchester. 7 p.m. Mr. L. Romers, "Tariffs."

Illuminating Engineering Society, at 15, Savoy Street, Strand, W.C. 6.30 p.m. Mr. H. Lingard, "The Use of Electric Lighting for Advertising Purposes."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. A. H. W. Wragg, "Regions of Wine Production in France." Mr. F. W. Barwick, "Under the Southern Cross from Cape Point to the Zambesi."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. A. Greenfield, "Practical Refrigeration for Ships."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Dr. A. Wade, "Madagascar and its Oil Lands."

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. Mr. S. K. Ratcliffe, "The Impact of America on Western Civilization."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture IV).

Transport, Institute of, at Hull. 7 p.m. Mr. C. E. R. Sherrington, "Latest Developments in American Railway Practice."
At the Society of Arts Hall, George Street, Edinburgh. 7.30 p.m. Dr. K. G. Fenelon, "Commercial Aviation."

University of London, at University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture V).
At King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture X).

WEDNESDAY, DECEMBER 12..British Academy, at the Civil Service Commission Building, Burlington Gardens. W. 5 p.m. Prof. Dr. John Edward Lloyd, "The Welsh Chronicles." (Sir John Rhys Memorial Lecture).

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. James Whitehouse, "Methods of Reducing Temperature in Deep Mining Work."

Public Health, Royal Institute of, 37, Russell Square. W.C. 4 p.m. Prof. Dr. E. W. Hope, "Industrial Diseases as viewed from the Standpoint of a Medical Officer of Health."

United Service Institution, Whitehall, S.W. 3 p.m. Mr. Sadao Saburi, "Japan's Position in the Far East."

University of London, at Australia House, Strand, W.C. 6 p.m. Film Lecture concerning the Gestetner Duplicator.
At the Royal College of Surgeons, Lincoln's Inn Fields, W.C. 4 p.m. Mr. F. W. Twort, "The Rôle of Bacteria in Nature." (Lecture V).
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lirica del Paradiso." (Lecture VI).
5.30 p.m. Dr. Richard Offor, "University Library Buildings."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Dragutin Subotic, "The History of Serbo-Croat and Slovene Literature in the 19th Century." (Lecture II).

THURSDAY, DECEMBER 13..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Birth Control and Racial Progress, Society for Constructive, at Essex Hall, Strand, W.C. 8 p.m. Dr. C. W. Saleeby, "Cancer Control via Birth Control Clinics."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Mr. P. A. Spalding, "Commercial Problems relating to the Applications of Electricity from the Shannon Distribution System."

Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. V. T. Harlow, "Sir Walter Raleigh in Guiana (1617)."

Linnean Society, Burlington House, W. 5 p.m.

Mechanical Engineers, Institution of, at the South Wales Institute of Engineers, Cardiff. 6 p.m. Dr. H. W. Swift, "Power Transmission by Belts: An Investigation of Fundamentals."
At the Engineers' Club, Manchester. 7.15 p.m. Mr. William Taylor, "Science in the Workshop."

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Mr. R. B. Deeley, "Aluminium-Silicon Alloys, their Properties and some Applications." (Joint Meeting with the Institute of British Foundrymen).

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Dr. J. J. Fox, "Recent Analytical Methods."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir R. Paget, "Human Speech as a Musical Phenomenon."

University of London, at University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 450-750 A.D." (Lecture VII).
5.30 p.m. Prof. Dr. R. W. Seton-Watson, "A Plea for the Study of Contemporary History."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "The Sculptors of the XVIth Century."

FRIDAY, DECEMBER 14..Astronomical Society, Burlington House, W. 5 p.m.

Chemical Industry, Society of, Burlington House, W. 8 p.m. Mr. N. Swindin, "The Air-Lift as a Chemical Engineering Appliance."

Dyers and Colourists, Society of, at Manchester. Prof. F. M. Rowe and Dr. C. P. Bean, "The Effect of After-Treatments on the Degree of Aggregation and Fastness Properties of Insoluble Azo Colours on the Fibre."

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. E. G. Herbert, "Machinability."

Metals, Institute of, at the University, Sheffield. 7.30 p.m. Mr. L. Wright, "Chromium Plating."

Oil and Colour Chemists' Association, at Milton Hall, Manchester. 7.30 p.m. Mr. R. A. Bellwood, "Present Day Methods of Oil Extraction."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Dr. Ezer Griffiths, "A Survey of Heat Conduction Problems."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. R. C. Reynolds, "Problems of the Future Development of Transport."
At the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Mr. H. Shaw, "Operation of the Newcastle Railway Panel."

University of London, at the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "England and Bohemia." (Lecture II).

SATURDAY, DECEMBER 15..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. Walter Bayes, "The Gulf between the Painter and the Public." (Lecture II).

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FRIDAY, DECEMBER 14th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows :—

LECTURE I—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

INDIAN SECTION.

MONDAY, DECEMBER 3RD, 1928. SIR REGINALD A. MANT, K.C.I.E., C.S.I., Member of the Council of India, in the Chair.

A paper on "The Sugar Industry of India" was read by SIR JAMES MACKENNA, C.I.E. The paper and discussion will be published in the *Journal* on January 4th.

FIFTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 5TH, 1928. THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., in the Chair.

A paper on "Fuel for Ships" was read by SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S. The paper and discussion will be published in the *Journal* on January 11th.

REPORT ON THE COMPETITION OF INDUSTRIAL DESIGNS, 1928.*

INTRODUCTION.

The Annual Competition of Industrial Designs was held for the fifth time this year. With regard to numbers of candidates and designs there has been an increase of nearly fifty per cent. over the figures of 1927, viz., 1,024 candidates, and 3,126 designs, as compared with 745 candidates and 2,224 designs last year, and this in spite of the fact that it was found necessary to make certain additions to the entry fees.

The increase is no doubt largely due to the number and value of the prizes offered. Altogether these amounted to over £1,600, including Travelling Scholarships of £100 and £75, and a large number of prizes of £50 and under.

The Council, however, are well aware that success in a movement of this sort is to be reckoned not in quantity but in quality. Some of the work submitted was poor, but there are certain features about the present Competition which are decidedly encouraging. In the typographical sub-sections of Book Production, for instance, some admirable work was shown, and the standard of excellence, which was considered high last year, has been still further raised. In two sub-sections of Textiles the firms who had offered prizes were so pleased with the work submitted that they awarded additional prizes. No difficulty was experienced in finding suitable candidates for the two Travelling Scholarships, nor in awarding the Art Congress Studentship to the candidate who last year won the Tootal Broadhurst Lee Company's Travelling Studentship, and whose work has, in the opinion of the Judges, greatly advanced as a result of her residence abroad.

On the other hand, it must be confessed that certain sections were very disappointing. In Glass, for instance, the designs were of the poorest, many candidates appearing to be content to copy the most commonplace specimens from trade catalogues. One or two sections of Textiles were unaccountably weak

*From considerations of space it has been found necessary to omit from the Report the lists of Central and Sectional Committees, of panels of judges, and of donors of prizes and scholarships. These are however included in the separately printed Report, copies of which may be obtained on application from the Secretary, Royal Society of Arts.

though, as already mentioned, others were distinctly encouraging. The work in the Furniture Section showed, on the whole, a great improvement on that submitted last year, especially on the technical side, and in one or two sub-sections of Architectural Decoration some very promising work was submitted.

On the whole, the Council feel that they have every reason to be satisfied with the result so far achieved by the Competition. A number of young designers of originality and promise have been brought to the notice of manufacturers and have secured excellent appointments. It is not possible to quote figures in this connexion as a good many appointments have been made without being reported to the Society ; but it is coming to be recognised that any competitor who makes his mark in this Competition greatly increases his chances of a successful future. Many manufacturers and publicity firms in search of designers with new ideas make a point of visiting the Exhibition every year in order to note the names and addresses of likely designers for their purpose, even though they may not have obtained prizes.

Competitors also gratefully acknowledge the help they derive from visiting the Exhibition, as it enables them to gain valuable knowledge of the requirements of manufacturers and advertisers. Fashion in design is constantly undergoing changes, and competitors are able to study the trend of public taste in design and posters and by the exercise of a little intelligent anticipation avoid sending in designs which lack originality, or are mere copies of existing productions. The exhibition of the designs also affords the general public a unique opportunity of gauging, as a whole, in London, the work done by the principal Schools of Art throughout the country.

Requests for information about the Competition were received from India, Canada, South Africa, Australia and New Zealand, and a few overseas competitors took part in this year's Competition. Distance from London is however, a serious handicap, it being impossible under present financial conditions to issue the Prospectus before January, which leaves very little time for a competitor in Australia to prepare and submit his designs for judging in July. The drawback could to some extent be overcome by announcing some of the main subjects of competition chosen for 1930 in the Prospectus issued for 1929. To enable them to do this, the Council need to re-establish a General Prize Fund, and if overseas manufacturers and trade organisations would assist the Society by contributing to the Fund so as to make it possible to announce a year in advance the offer of substantial prizes open to overseas competitors, it is evident from the interest taken in the Competition by residents in many parts of the Empire, that such offers would meet with a wide-spread response from competitors in the British Empire overseas.

For the benefit of those whose work is approved by the Judges for exhibition, a Bureau of Information has been opened by the Society, for the registration of the names of those exhibitors who desire to obtain employment as designers.

The information is placed at the disposal of manufacturers, and it is hoped that the Bureau will be of service both to designers and manufacturers.

The Council desire to express their appreciation of the generosity of those firms and individuals who have provided the scholarships and prizes; to the Judges who devoted much time and care to a very difficult task; to the authorities of the Imperial College of Science and Technology who provided accommodation for the reception of the designs, and to Lieut.-General Sir William Furse, K.C.B., D.S.O., Director of the Imperial Institute, through whose kindness the Society received permission to judge the designs and to hold an exhibition of selected work in the Exhibition Pavilion of the Institute.

Number of Entries.

The total number of competitors who entered for the various sections of the Competition was 1,024 Of these, 739 were students of Schools of Art, and 285 non-students.

The number (of mounts) of designs submitted was 3,126, divided as follows :—

Architectural Decoration	305
Textiles	959
Furniture	152
Book Production	206
Pottery and Glass	364
Miscellaneous	1140
Total	3,126

Reports of Judges.

James H. Hyde Travelling Scholarship.

This scholarship, of the value of £100, given by James H. Hyde, Esq., was offered for the designs showing the greatest merit in respect of invention and draughtsmanship among those submitted by candidates under 30 years of age for any of the prizes in the section of Architectural Decoration or Textiles. The scholarship was awarded, subject to the conditions stated in the Prospectus of the Competition, to:

Thomas Mitchell, Glasgow School of Architecture, whose design for a petrol-filling station won the prize in Sub-section 6 of the Architectural Section and who also sent in designs which were commended by the Judges in Sub-sections 1 and 2.

Art Congress Studentship.

The Art Congress Studentship of the value of £50, was open, under the conditions of the Competition, to any candidate in any Section (preference being given to candidates actually engaged as practising craftsmen or designers and not above the age of 28 years). The Studentship was awarded by the Judges to:

Miss Sadie Nixon, Slade School of Art, University College, Gower Street, W.C., for textile designs Nos. 3002 to 3012. These designs consist of studies executed by Miss Nixon abroad during her tenure of the Tootal Broadhurst Travelling Studentship, which was awarded to her last year, and were shown at the Exhibiton this year in accordance with the conditions of the Studentship.

SECTION I.—ARCHITECTURAL DECORATION.

SUB-SECTION 1. *Decorative Architecture. Prize of £50 offered by the Royal Society of Arts for a Design for an Entrance Hall to a Cinema.*

The Judges were unable to recommend the award of any prize, but the design submitted by

Thomas Mitchell, Glasgow School of Architecture, is Commended. (Nos. 1332 and 1333).

Mr. Mitchell should avoid pursuing the chimera of ultra-modernism. He has a decorative sense and a feeling for an *ensemble*. His work shows that he can grasp the essentials of a problem, and experience will teach him to appreciate simplicity and economy.

SUB-SECTION 2. *Prize offered by Messrs. Bagués, Ltd., for a Design for a Wrought Iron Canopy for the Main Entrance of a Popular Theatre.*

The awards are as follows :—

A Prize of £35 to John G. Sidebottom, Leeds College of Art. (Nos. 1673 to 1677).

A Prize of £15 to John A. C. Howard, 90, Palmerston Road, Bowes Park, N.22. (Nos. 1279 to 1283).

Commended :

Thomas Mitchell, Glasgow School of Architecture. (Nos. 1334 to 1337.)

Mr. Sidebottom's general scheme is good, but there is too little relief, and the wording does not show up sufficiently.

Mr. Howard's canopy does not afford sufficient shelter, and there is little or no artistic relation between the canopy and the standards.

Mr. Mitchell's designs are commended for originality, but the plan of the section is difficult to understand.

SUB-SECTION 3. *Lewis Berger Scholarship of the value of £60, tenable at the Royal College of Art for a period of three months for the purpose of study in Decoration and Decorative Painting.*

The awards are as follows :—

The Lewis Berger Scholarship of £60 to Henry G. Glyde, Royal College of Art. (No. 3053.)

Commended :

Alfred Garner, Stockport School of Art. (No. 3033.)

J. R. Wallace Orr, Glasgow School of Art. (No. 3087.)

Although the Judges did not care for Mr. Glyde's imitation of the primitive, and his attempt to get a modern effect from it, they felt that his sense of drawing was good, and that he would reap substantial benefit from a further course of study at the Royal College of Art. **The enlarged detail should be a completely finished section, executed in the actual colours of the coloured sketch of the full design.**

SUB-SECTION 4. *Prize offered by Messrs. Shanks & Co., Ltd., for a Design for a Bathroom in a Private Mansion.*

The awards are as follows :—

The First Prize of £31 10s. and the Second Prize of £15 15s. are divided equally between :—

Leonard S. Dixon, 7, Broadway Market, Victoria Avenue, Southend-on-Sea. (No. 1235), and

Stanley H. Smith, 240, Lavender Hill, Enfield, Middlesex. (Nos. 1424 and 1425.)

Highly Commended :

William Leslie Nicholson, L.C.C. School of Building, Brixton, S.W. (No. 1020.)

Design No. 1424 shews an excellent arrangement of the Sanitary Appliances in relation to the outside wall. It would probably be an advantage to have a door to give communication between the W.C. Compartment and the Bidet.

In design No. 1235, the bath is placed in a recess which would not get much daylight. It would be an improvement to have the Bidet where the lavatory basin is placed so as to bring the Bidet nearer to the W.C.

Design No. 1020 is highly commended. It is simple and direct. There is no need, however, for a step in front of the bath. This would be found objectionable in use.

The designs submitted shew, generally, a lack of originality. For convenience in use the hot water towel rail should be near the bath and the Bidet should be readily accessible from the W.C. These considerations were frequently overlooked. Rounded angles between walls and floors were frequently omitted.

SUB-SECTION 5. *Prize offered by A. J. Davis, Esq., F.R.I.B.A., for Design for a a Decorative Fountain.*

The awards are as follows :—

The Prize of £15 is divided equally between :—

John N. Summerson, 61, Belsize Avenue, N.W.3. (No. 415.)

Raymond M. Walker, Leeds College of Art. (No. 1678.)

The Judges were disappointed to find that more architects did not compete in this Sub-Section, the designs submitted being generally very poor. The Prize has been award d conjointly to the competitors whose schemes most nearly satisfy the conditions.

SUB-SECTION 6. *Prize offered by Murray Adams-Acton, Esq., for a Design for a Petrol-Filling Station.*

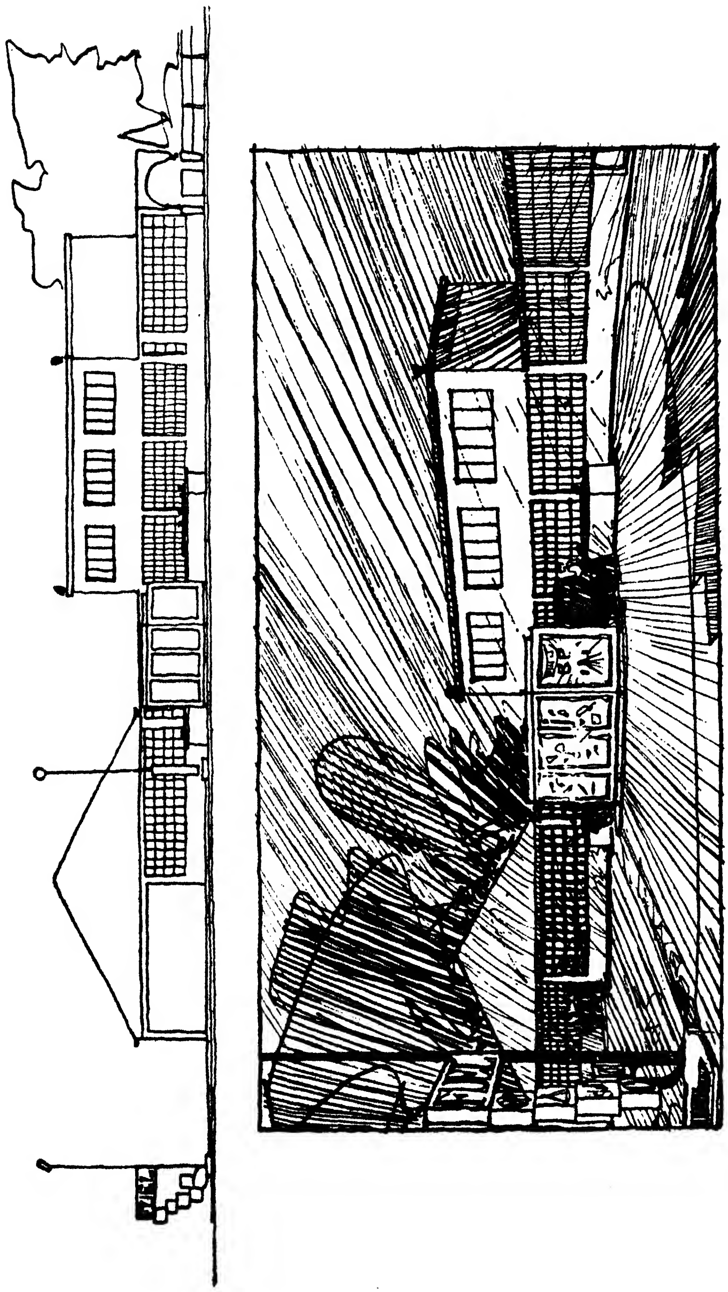
The awards are as follows :—

A Prize of £25 to Thomas Mitchell, Glasgow School of Architecture. (No. 1339.)

Commended :

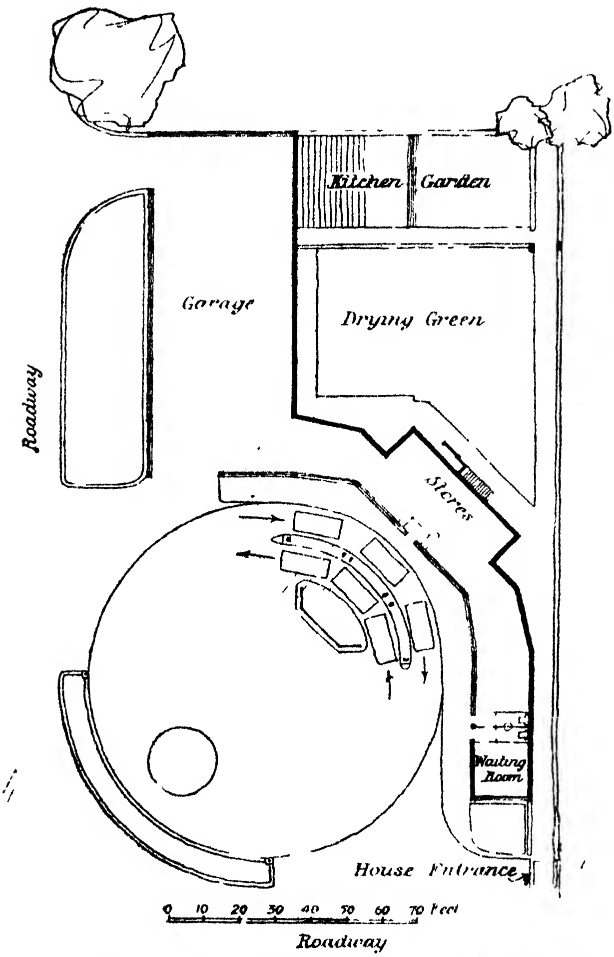
Robert J. H. Minty, A.R.I.B.A., A.M.I.Struct.E., 21, Great Peter Street, S.W.1. (Nos. 1004 and 1005.)

Among the designs for Petrol-Filling Stations, that of Mr. Mitchell (Glasgow School of Architecture), was considered to fulfil the conditions most satisfactorily, the prime reason being that the plan is reasonable and shows easy means of ingress



Elevation of Design by Thomas Mitchell for a Petrol Filling Station.

and egress to the pumps. A dual function is served by the posters which screen the pumps. The buildings are simple in character and capable of economic erection, while a further merit lies in the fact that the scheme can be developed to serve increasing needs. Mr. Minty's design is the best of the designs schemed on ordinary lines where the pumps are displayed.



Plan of Design by Thomas Mitchell for a Petrol-filling Station

SUB-SECTION 7. *Prize of £25 offered by the Royal Society of Arts for a Design for a Silver Cup for the Swiney Prize for the best published work on Jurisprudence.*

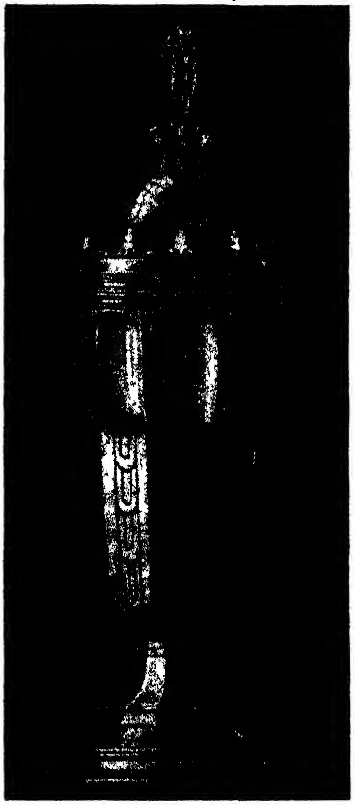
The awards are as follows :—

A Prize of £25 to Edward N. H. Spencer, 4, Conduit Street, W.1. (No. 1427.)

Highly Commended :

Miss Mary H. Rowlinson, Manchester Municipal School of Art. (No. 2776.)
Edward N. H. Spencer, 4, Conduit Street, W.1. (No. 1426.)

No. 1427 undoubtedly stands out for originality. Proportions, outline, and detail are all very good. Possibly the sort of scale decoration might be aggressive in the drawing, but no doubt this could be subdued in the execution. No. 1426 is of very good outline and proportion. No. 2776 is also of very good outline and proportion, and shows great promise. The foot however is rather short.



Design for a Silver Cup by Edward N. H. Spencer

SECTION II.—TEXTILES

SUB-SECTION 1 *A set of at least four designs for printed dress goods, a set of at least four designs for printed furnishings; and a set of at least four designs for woven dress goods. A Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company, Ltd.*

The Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company, Ltd., and an Owen Jones Medal, are awarded to Miss Barbara Lebkuchen, Slade School of Art, University College, Gower Street, W.C., (Nos. 372 to 383.)

The following awards are also made :—

A Royal Society of Arts Prize of £5 to Miss Betty M. Heesom, L.C.C. Central School of Arts and Crafts (Nos. 923 to 930, 932, 934 and 935.)

A Royal Society of Arts Prize of £3 to Miss Angela Bradshaw, Manchester Municipal School of Art (Nos. 2696, 2698, 2699 and 2750.)

A large number of designs were submitted, but the standard was not so encouraging as last year. In one or two notable cases the designer seems less accomplished than before. Miss Barbara Lebkuchen, however, sent in a charming set of designs, which are extremely well carried out and eminently practical. Miss Betty M. Heesom also shows considerable originality, as does Miss Angela Bradshaw. In these two cases more care in execution and more attention to practical points would have much improved their exhibits. Extravagance in design is not necessarily originality and ingenious simplicity is not sufficiently considered. Further, fine taste in colour is wanted rather than multiplicity of colours in one scheme, and several designs, good in form, suffered from poor distribution and choice of colour.

The Judges are pleased to note that last year's winner of the Studentship, Miss Sadie Nixon, has distinctly profited by the opportunity afforded her. Her set of designs may be recommended to this year's competitors as showing care in execution combined with originality of subject.

Sub-Section 2. *Designs for Cretonne based on any floral subject other than the rose. Prizes offered by Messrs. Simpson & Godlee, Ltd.*

The awards are as follows :—

The First Prize of £52 10s. to Granville Hannah, 78, Rochdale Road, Middleton, Manchester. (No. 949.)

The Second Prize of £31 10s. to Miss Margaret H. McColl, 9, Sherbrooke Avenue, Pollokshields, Glasgow, S.1. (No. 617.)

The Third Prize of £21 to Henry C. Whaite, L.C.C. Central School of Arts and Crafts. (No. 722.)

A Special Prize of £15 15s. to Miss Janet McIntyre Guthrie, Royal Technical College, Glasgow. (No. 1260.)

A Royal Society of Arts Prize of £10 10s. to Miss Margaret Crees, Swindon School of Art. (No. 1864.)

The entries in this section were numerous and well up to, but not above, the standard of previous years. Many of the designs submitted were weak in colour and not original in conception. On the other hand, several designs showed considerable originality in composition and in colour scheme. The design awarded a *special prize* of £15 15s. is distinctly original, but suffers from insufficient care in drawing and execution. Competitors should be advised to take more care in this, the practical side of the question of designing for reproduction in cretonnes.

The three prize-winning designs are all good in treatment and in choice of subject and also practical. The first prize design is, undoubtedly, the best. The design recommended for a Royal Society of Arts prize is original in conception, but perhaps hardly so suitable for reproduction as the others. On the whole, the competitors are to be congratulated on a good exhibition of useful designs.

Sub-Section 3. *Designs suitable for printing by block on 30in. width of cloth, each design to be accompanied by five different colour scheme suggestions. Prizes offered by Messrs. G. P. & J. Baker, Ltd.*

On examining the work submitted, Mr. G. P. Baker decided to increase the amount of the prize money so as to allow for a first prize of 20 guineas, two prizes of 15 guineas each, and one prize of 10 guineas.

The awards are as follows :—

The First Prize of £21 to Miss Vera M. Moller, Royal College of Art. (Nos. 618 to 622.)

A Prize of £15 15s. to each of the following :—

Miss Nancy Hallworth, Manchester Municipal School of Art. (No. 2714.)

Miss E. Lawrence, Manchester Municipal School of Art. (No. 2739.)

A Prize of £10 10s. to Miss Doris K. Taylor, Liverpool School of Art. (Nos. 2884 and 2885.)

The design winning the first prize is original in conception, and well in harmony with modern taste. While very fine in its lines, it is adapted for direct printing by block on tinted grounds, and for dark-coloured ground it can be made adaptable for discharge printing by machinery or by block.

Design No. 2714 is very practically drawn, the effect being produced with only a small amount of detail. The complete design shows the best colouring scheme of all the works submitted for this competition. There is also considerable merit in the composition of design No. 2739. The furrows of the ploughed field are too much emphasized, and, especially in some schemes of colouring, there would have to be some modification in order to obviate a blemish. Design No. 2884 is simple, well-drawn, highly-finished and thoroughly practical. It shews much consideration for the method by which it is to be produced, and the effect is decidedly good. Some of the colour schemes in this set were of considerable merit. One could recommend such a design for hangings in most rooms with ordinary decoration.

Students of design must remember that a fabric with very extravagant ornament often necessitates the scrapping of furniture in order to keep the whole scheme in harmony.

The Judges consider that the works exhibited in this small class are generally creditable, and that an improvement is distinctly noticeable when a comparison is made with the general standard of former years.

SUB-SECTION 4. (*a*) *Design in the " modern " style suitable for a printed cotton or linen fabric for use in house furnishing.*

(*b*) *Design in the " modern " style suitable for a printed tapestry or moquette for use in furniture covering. Prizes offered by Messrs. Arthur H. Lee & Sons, Ltd.*

The awards in Sub-Section 4 (*a*) are as follows :—

The First Prize of £20 to Thomas J. Corbin, Royal College of Art. (Nos. 1201 and 1202.)

The Second Prize of £10 to Miss Mary D. Cooper, Royal College of Art. (No. 2628.)

Highly Commended :

Miss Phyllis Donaldson, Royal College of Art. (No. 1522.)

Miss G. Gervis, L.C.C. Central School of Arts and Crafts. (No. 889.)

Miss K. Bernice Williams, Manchester Municipal School of Art. (No. 2804.)

Commended :

Miss Evelyn G. Widdop, Manchester Municipal School of Art. (No. 2800.)

The awards in Sub-section 4 (*b*) are as follows :—

The First Prize of £20 to Miss Phyllis Donaldson, Royal College of Art. (Nos. 1524 and 1525.)

The Second Prize of £10 to Miss Mary D. Cooper, Royal College of Art. (No. 2630.)

Highly Commended :

Miss Barbara Heath, 194, Greenvale Road, Eltham Park, S.E.9. (No. 1271.)

Miss Violeta E. D. Janes, Watford School of Art. (No. 1910.)

Miss Olive Nash, Reading University School of Art. (No. 1364.)

The Judges find that a great many of the competitors have failed to comply with the conditions under which the prizes were offered.

Failures in this respect fall mainly under two heads :—

(1) The ignoring by some of the competitors of the fact that designs in the "Modern" style were required, and (2) the failure of the very large majority of the competitors to display their designs for tapestry or moquette in "colourings appropriate to the fabric and purpose for which it is intended."

The colourings of these designs in nearly every case were far too thin to give the colour-effect of fabrics such as Tapestry or Moquette. Competitors have obviously been thinking of producing a prize-winning sketch (or, in some cases, of submitting old designs that they already had on hand, with which they thought they might get a prize), instead of visualising a beautiful fabric of which their sketch was intended to illustrate the design and colour.

The designs for printed linen and cotton fabrics were, on the whole, more satisfactory both as regards design and colour.

Design No. 2800 was felt to call for special comment on account of its charm and the happy inventiveness displayed; at the same time, the scenic treatment renders it less generally practical, though for nursery decoration, for instance, it might be altogether delightful.

SUB-SECTION 5. *Design for an eight-colour Jacobean Block for 50in. Linen. Prizes offered by Messrs. Story & Co., Ltd.*

The awards are as follows :—

The First Prize of £15 15s. to Miss Ida M. Dight, Brackley, Crofton Lane, Orpington, Kent. (No. 1236.)

The Second Prize of £10 10s. to Mrs. Marjorie Reynolds, The Knightons, 112, Gordon Road, Camberley, Surrey. (No. 1502.)

Although the design winning the first prize (No. 1236) is plainly based on a well-known Jacobean embroidery, it shows originality in treatment without departing from the characteristics of English design in the 17th century. The design is well conceived and skilfully adapted to the style. The colouring is pleasant, but it will require reinforcing to some extent when reproduced. The second prize is awarded to No. 1502. The design is, perhaps, thin and in this respect it cannot be compared with No. 1236. The colouring perhaps errs in the opposite direction to that example, and there is a suggestion of harshness which needs some modification.

Several other works sent in have shown a real knowledge of the style on which the designs were to be based, but some have not, and the Judges would impress upon students the advisability of making themselves well acquainted with historical styles.

SUB-SECTION 6. *Designs suitable for printing on 50in. linen for use as draperies or furnishings, based on any English period style of decoration. Prizes offered by Messrs. F. W. Grafton & Co., Ltd.*

The awards are as follows :—

The First Prize of £30 to Miss Edith L. V. Ailsby, 45, Seagrave Road, Fulham, S.W.6. (No. 1185.)

The Second Prize of £15 to Miss Winifred Orde-Ward, L.C.C. Central School of Arts and Crafts. (No. 418.)

The Judges are disappointed with the number of entries, which was only nine in all. Generally speaking, the designs submitted are not particularly outstanding. Miss Edith Ailsby's " Flowers in Basket " design stands out, and is distinctly good. Also Miss W. Orde-Ward's is quite clever and original. Apart from these there is nothing very new.

SUB-SECTION 7. *Designs for Silk Fabrics for Furniture and Decoration in which one or more shuttles are used. Prizes offered by Messrs. Warner & Sons.*

No awards were made in this Sub-Section.

SUB-SECTION 8. *Design for an Axminster Carpet suitable for a Drawing Room. Prize offered by Messrs. John Crossley & Sons, Ltd.*

The Judges were unable to recommend that the full prize should be given, but the following awards were made :—

A Prize of £15 to Miss Barbara Lebkuchen, Slade School of Art, Gower Street, W.C., for her two designs. (Nos. 384 and 385.)

A Prize of £5 to Walter Shepherd, Kidderminster School of Art. (Nos. 1090 and 1091.)

Commended :

G. I. Foreman, 11, Westgate, Halifax, Yorks. (Nos. 68 and 69.)

Frank Heaton, 68, Bacup Road, Todmorden. (Nos. 98 and 99.)

This class on the whole was poor, and, with the exception of Miss Lebkuchen's designs, there was an absence of originality. No design was considered by the Judges worthy of the £30 prize offered.

SUB-SECTION 9. *Two Designs suitable for Axminster Carpets for a Lounge. Prizes offered by Messrs. Tomkinsons, Ltd.*

The awards are as follows :—

The First Prize of £20 to Cyril Astle, Grand View P.O., Brantford, Ontario, Canada. (Nos. 1175 and 1176.)

The Second Prize of £10 to Miss Margaret E. Hays, The Mythe, Neville Road, Bognor, Sussex. (Nos. 550, 551 and 553.)

Highly Commended :

Frederick E. R. Everley, Kidderminster School of Art. (Nos. 1735, 1736 and 1737.)

This class contained many designs of interest and originality. The first prize designs were marked by good conception of form and well executed draftsmanship. The designs of Miss Hays, who won the second prize, possessed novelty and freshness, particularly No. 551, which contained an idea that could be developed with pleasing effect.

SUB-SECTION 10. *Prizes offered by Messrs. A. Herbert Woolley & Co., Ltd., for (a) design for a Lace Flounce not less than 27in. wide in Artificial Silk and Silk, for dyeing in two colours, and (b) a set of designs for Lace suitable for trimming Ladies' Underclothing, comprising 2in. Lace; 2in. Insertion; 4in. Lace; 6in. Novel shape made intersecting so as to get two shapes in the 6in. width, with outer edges that would not require scalloping.*

The awards in 10 (*a*) are as follows :—

A Prize of £7 to Miss Winifred E. Bexton, Nottingham School of Art. (No. 2914.)

A Prize of £5 to Miss Maud L. Cass, Nottingham School of Art. (No. 2932.)

A Prize of £3 to Geoffrey R. Dearden, Nottingham School of Art. (No. 2942.)

The award in 10 (*b*) is as follows :—

A Prize of £5 to Miss Winifred E. Bexton, Nottingham School of Art. (No. 2915.)

There was an encouraging improvement in the number and quality of the designs for flounces, though the designs for laces were not only few in number, but, with one exception, of little merit. The flounce design to which the first prize was awarded was of special merit owing to the excellent balance of the two colour effects, though different colours to those shewn in the design would be actually used by the manufacturer.

SUB-SECTION 11. *Designs for a set of four panels of hand embroidery. Prize offered by Mrs. Lewis F. Day.*

The awards are as follows :—

A First Prize of £10 to Miss Nancy Guest, Manchester Municipal School of Art. (No. 2713.)

A Second (Royal Society of Arts) Prize of £5 to Miss Winifred R. Simmonds, Royal College of Art. (No. 1563.)

A Third (Royal Society of Arts) Prize of £2 to Miss Gladys A. Brailsford, Battersea Polytechnic School of Arts and Crafts. (Nos. 2258 and 2259.)

Commended :

Miss Ethel Nettleship, 46, Powis Square, W.11. (No. 397.)

The designs for this competition were, for the most part, rather disappointing, as showing little originality. There was also too great a tendency to what might be called the "Sale of Work" class of embroidery. Some designers had not indicated the colours, and others submitted designs which were too pictorial or otherwise ill-calculated to be reproduced in needlework. The winning design shows an original treatment in colour and composition of pictorial subjects, and is well adapted for embroidery. The second and third designs are also original in subject and treatment but perhaps not quite so suitable for immediate rendering in needlework. Designers of embroidery patterns should bear in mind that apart from originality and good composition, colour and stitch should also be considered and indicated.

SUB-SECTION 12. *Design for Wallpaper suitable for either a living room or a bed-room. Prize offered by the Wallpaper Manufacturers, Ltd.*

The awards are as follows :—

A Prize of £10 10s. to Victor R. Brown, L.C.C. Hammersmith School of Arts and Crafts. (No. 211.)

Highly Commended :

Miss Eileen Langmead, "Hamont," Goodwyn Avenue, Mill Hill, N.W.7. (No. 1312.)

Commended :

Victor R. Brown, L.C.C. Hammersmith School of Arts and Crafts. (Nos. 208, 209 and 210.)

The wallpaper designs numbered less than 40, and of these the drawings of Victor R. Brown, of the Hammersmith School of Art, were outstanding, both from the point of view of their practicability and commercial value.

The design of Miss Langmead shewed vision and is highly commended. Of the rest, there was little which could be considered praiseworthy, or which shewed much intelligent guidance in the training of the students.

SUB-SECTION 13. *Additional Prizes offered by Messrs. Turnbull & Stockdale, Ltd., for the two most original designs intended for Cretonne or hand block printing, which, whilst showing suitability to material and use, shall be judged mainly for their imaginative and aesthetic qualities. The Prizes were open to students or designers serving apprenticeship in studios or drawing offices, not over 21 years of age on December 31st, 1927. Entries in Sub-sections 1, 2, 3, 4, 5 and 6, provided the competitor complied with the above regulation, were eligible for these additional Prizes.*

The awards are as follows :—

The First Prize of £15 to Miss Mollie A. Maylam, Regent Street Polytechnic School of Art. (No. 1356.)

The Second Prize of £10 to Miss Violeta D. E. Janes, Watford School of Art. (No. 1910, entered for Sub-section 4 (*b*)).

Highly Commended :

Thomas J. Corbin, Royal College of Art. (No. 1202, entered for Sub-section 4 (*a*)).

Miss G. M. Dickinson, L.C.C. Hammersmith School of Arts and Crafts. (No. 2071.)

The two first designs were awarded prizes on the grounds of their imaginative and aesthetic qualities, combined with simplicity of treatment and suitability for their purpose.

The designs submitted in this sub-section were, on the whole, fair, with three or four exceptions. Generally they did not shew a very good colour sense. Colour harmony should be studied to a greater extent in Schools of Art than at present seems to be the case.

SECTION III.—FURNITURE.

The Competition in Furniture attracted a very considerable number of designs in the various sub-sections, which may be divided roughly into three categories :—

(*a*) The frankly pedestrian drawing in which the details of some historical style have been embodied in a more or less uninspired composition.

(*b*) Designs evidently influenced by a modern mode of expression in the furniture trade and showing traces of a half-assimilated continental conception of design.

(*c*) Designs submitted by students who have conceived of their task as necessitating originality, and expressing too great a regard for novelty for the sake of novelty.

SUB-SECTION 1. *Prize offered for Furniture for a Dining-Room.*

The awards are as follows :—

A First Prize of £20 to Robert Balfour Graham, Barnstaple School of Art. (No. 142.)

A Second Prize of £5 to William H. Russell, c/o Mr. W. Stanley, Leamington Road, Broadway, Worcs. (Nos. 1547 and 1548.)

Highly Commended :

James Watson, 13, Albany Road, West Twerton, Bath. (No. 324.)

Cyril L. White, Nottingham School of Art. (Nos. 2977, 2978, 2979 and 2980.)

The first prize (No. 142), was allotted to a scheme in silky oak inlaid with laurel wood. The Judges hesitated in giving this first place on account of the questionable construction of the chair backs, but were impressed by the general proportions and workman-like expression.

The design awarded second prize (No. 1547), is a design of an entirely different character which is approached from the point of view of the cabinet maker rather than the mere drawing board designer. It can hardly be doubted that this drawing is made by a man who has either worked at the bench or has been closely associated with workshop conditions. It is a design which is evolved from cabinet making and chair making experience. Here is a design which is new, but nevertheless soundly English in its conception. There has been no coquetry with Parisian novelties.

Mr. James Watson (No. 324), easily takes first place as a water colour artist in portraying furniture, but the facility and skill with which he can make an extraordinarily pleasing group occasionally leads him into defects as far as construction is concerned. Mr. Cyril White's scheme (Nos. 2977-2980), for a dining room was very favourably commented on by the Judges, and he probably lost the first or second place on account of the rather startling glazing of his cabinet, and it was not entirely clear what would be the purpose of this cabinet in a dining room.

SUB-SECTION 2. *Prizes offered for Furniture for a Drawing-Room.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £5 to each of the following :

Duncan McC. Grassie, 14, Blythswood Terrace, Sandy Road, Renfrew. (No. 907.)

Douglas L. Hadden, Wycombe Technical Institute, High Wycombe. (No. 1685.)

A Prize of £3 3s. to John A. L. Hill, L.C.C. Central School of Arts and Crafts. (Nos. 534 and 535.)

This sub-section was weakest both in the number of designs submitted and their quality. This may be attributable to the passing of the drawing room and the coming of the more intimate furnishing of the sitting room.

Mr. D. McCallum Grassie's set of drawings are conventional, and rather uninspired; the line of the cabriole legs in his design (No. 1907), is exaggerated and open to question. Mr. J. A. L. Hill sent in a distinctly modern design (No. 534-5), and it would pay him to take a little time to present his designs in a more attractive manner.

SUB-SECTION 3. *Prizes offered by the London Cabinet and Upholstery Trades Federation, for Designs for a Best Bedroom Suite in the Modern Style.*

The Judges were unable to recommend that the full amount of the First Prize should be awarded to one competitor. They accordingly decided to pool the amount available for the first and second prize, and to make the following awards:—

A Prize of £7 10s. to each of the following:

Frederick W. de la Mare, L.C.C. Brixton School of Building. (Nos. 961 and 962.)

Cyril L. White, Nottingham School of Art. (Nos. 2974, 2975 and 2976.)

An Owen Jones Medal is also awarded to Cyril L. White. (Nos. 2974 to 2976.)

A Prize of £5 to each of the following:

Donald Williamson, Sheffield College of Arts and Crafts. (No. 2159.)

James Watson, 13, Albany Road, West Twerton, Bath. (Nos. 326 and 327.)

Highly Commended:

John A. L. Hill, L.C.C. Central School of Arts and Crafts. (Nos. 536 and 537.)

Commended:

Alwyn G. Allen, Mr. J. H. Roberts' Studio, 30, Royal Crescent, W.11. (No. 1177.)

Frederick C. Gilray, Edinburgh College of Art. (Nos. 2650 and 2651.)

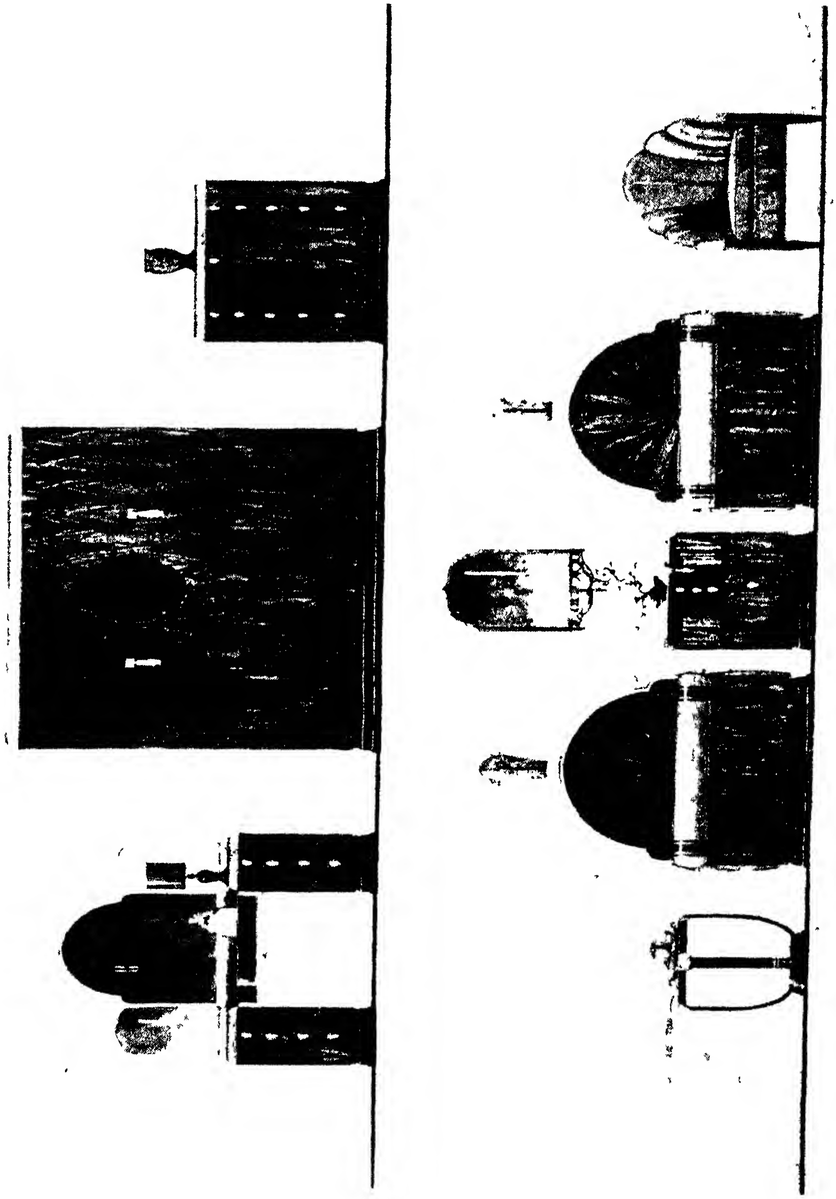
Duncan McC. Grassie, 14, Blythswood Terrace, Sandy Road, Renfrew. (No. 908.)

This sub-section attracted by far the greatest number of designs. The Judges had very little difficulty in at once rejecting a great number of them. The conditions in this sub-section were that the designs should be distinctly original, and many of the competitors had lost sight of this. It is not sufficient in a competition where originality is demanded to make slight variations in designs which can be seen in the show windows of any large retail furnishing establishments. There were four schemes of outstanding merit submitted, the first and second places being given respectively to Mr. F. W. De la mare, a competitor whose work has been successful in former Competitions, and Mr. C. L. White, for a design in which originality was tempered by restraint. The third place was gained by Mr. Donald Williamson, who is evidently at some variance with Hogarth, for there is not a curved line anywhere in his scheme. This dependence on angularity has not betrayed him into undue harshness, because he is saved by an intrinsic sense of proportion. Mr. James Watson, in his Bedroom Furniture, as in some of the other designs which he submits, is too apt to think of wood in terms of marble, but his draughtsmanship and the general presentation is admirable.

SUB-SECTION 4. *Prize offered for Design for Two Sets of Dining-Room Chairs.*

The award is as follows:—

A Prize of £5 5s. to Sydney J. Stokes, Regent Street Polytechnic School of Art. (Nos. 1060 and 1061.)



* Design by Frederick W. de la Mare for a best bedroom suite in modern style.
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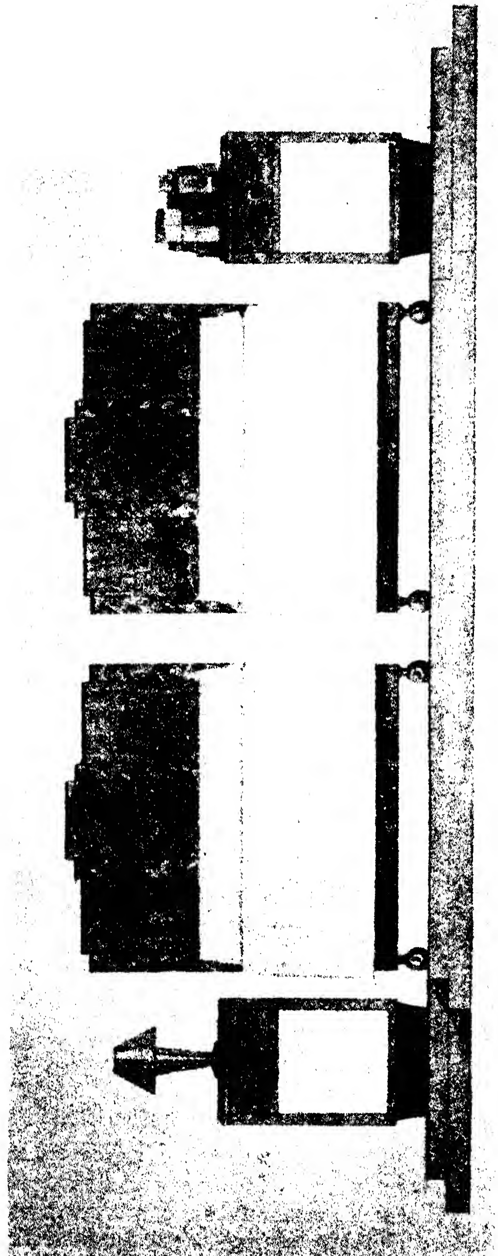

* Design by Cyril L. White, for a best bedroom suite in modern style, the elevation above showing the two beds with pedestal cupboards.

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SUB-SECTION 5. *Prize offered by the "Cabinet Maker" for a design for a Cabinet for a Wireless Receiving Set.*

The awards are as follows :—

A Prize of £5 5s. to William F. Payne, Bath School of Art. (No. 1036.)

Highly Commended :

William F. Payne, Bath School of Art. (No. 1038.)

In this Sub-Section a number of designs were submitted, some of them frankly disguises and others unhappy mixtures. The problem of designing a wireless cabinet had not been approached with the clarity of intention which would have made it possible to incorporate the apparatus in the design in an agreeable manner, and the feeling of the necessity for disguise predominated. The prize-winning design by Mr. William F. Payne, was the nearest approach to a new piece of furniture, new in intention as well as in form ; and another design by the same competitor was highly commended also, for it showed a grasp of the fundamental problem presented.

SUB-SECTION 6. *Prize offered by the Star Manufacturing Company for a set of six Designs for Decoration of Side Panels of Baby Carriages.*

The award is as follows :—

A Prize of £10 to Miss Honor Howard-Mercer, Guildford School of Art. (No. 980.)

The entries were only few in number, doubtless owing to the subject being new. Two of the designs are not suitable for the purpose in view, though they could be applied to other trades, and are quite good in themselves.

The third entry (No. 980), shows a grasp of the subject from a utility as well as artistic standpoint, and this secures the prize offered.

If the subject were developed more on these lines in subsequent Competitions, there would be more scope for prize-giving.

SECTION IV.—BOOK PRODUCTION.

SUB-SECTION 1. *A Title-page set from type, with or without printers' ornaments.* [The book prescribed in each Sub-Section was "Westward Ho !" (Crown Quarto).]

The awards are as follows :—

A Prize of £4 4s. to David C. Shand, London School of Printing & Kindred Trades. (No. 1411.)

A Prize of £3 3s. to each of the following :—

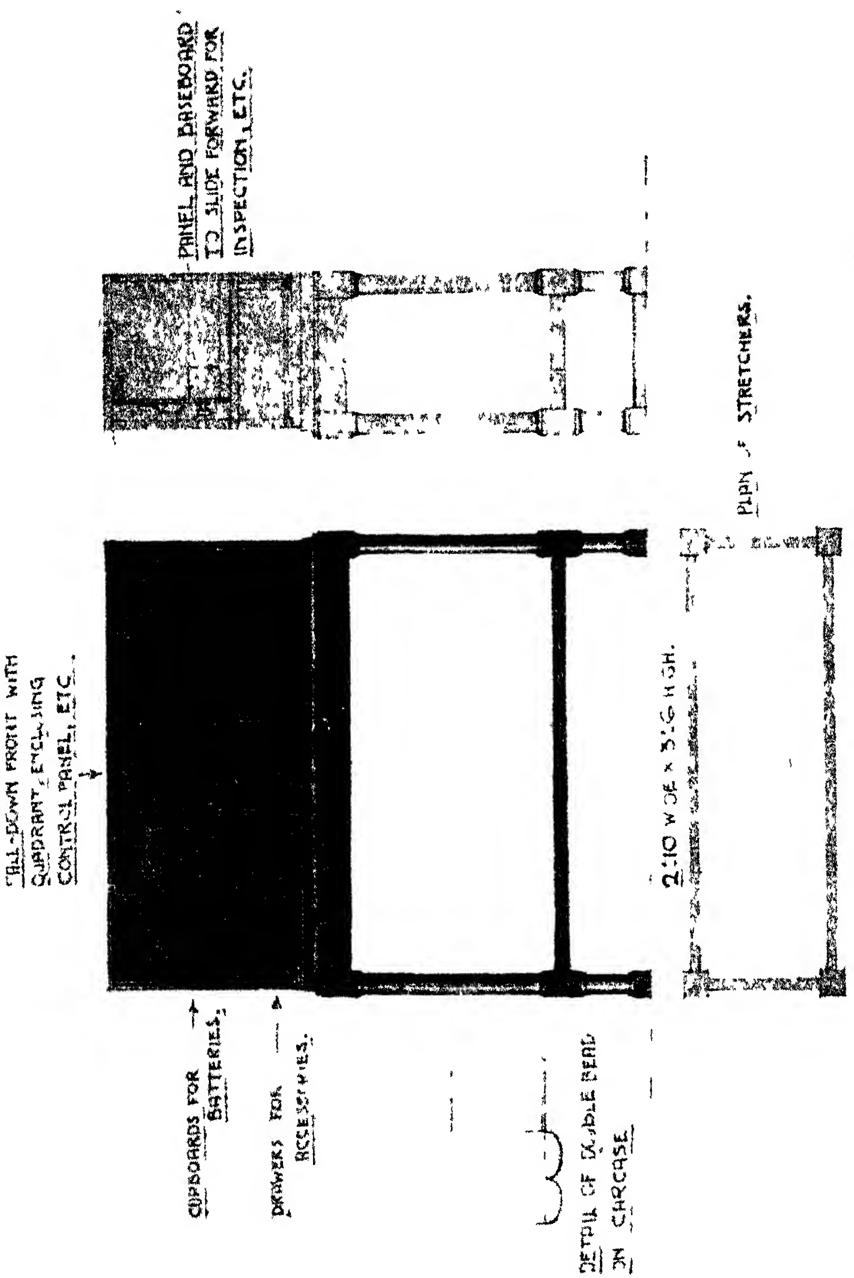
John F. Adams, London School of Printing & Kindred Trades. (No. 1785.)
Herbert G. Newman, London School of Printing & Kindred Trades. (No. 1342.)

Highly Commended :

William H. G. Adams, London School of Printing & Kindred Trades. (Nos. 1179 and 1182.)
E. Thurston Lewis, London School of Printing & Kindred Trades. (No. 1299.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1413.)

Commended :

Peter Carruthers, 6, Hughenden Road, Horfield, Bristol. (Nos. 499 and 502.)



* Design by William F. Payne to be executed in walnut for a cabinet for a wireless receiving set
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SUB-SECTION 2. *A Contents page, set from type.*

The awards are as follows :—

A Prize of £6 6s. and a Prize of £4 4s., to George L. Riddell, London School of Printing & Kindred Trades, for Nos. 1779 and 1778 respectively.

An Owen Jones Medal is also awarded to George L. Riddell. (Nos. 1779 and 1778.)

Highly Commended :

Francis Doherty, London School of Printing & Kindred Trades. (No. 1222.)
George L. Riddell, London School of Printing & Kindred Trades. (No. 1777.)

Commended :

Alfred J. Bouch, London School of Printing & Kindred Trades. (No. 1770.)
Frederick C. Errington, Camberwell School of Arts & Crafts. (No. 1577.)

SUB-SECTION 3. *Three pages of text, set from type.*

The awards are as follows :—

A Prize of £4 4s. to George L. Riddell, London School of Printing & Kindred Trades. (No. 1772.)

A Prize of £3 3s. to each of the following :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1774.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1415.)

Highly Commended :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1773.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1416.)

Commended :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1775.)

The Judges are impressed with the increasing interest taken in Sub-Sections 1, 2 and 3. Every year shows an increase in the number of entries, and what is more pleasing, a higher standard of craftsmanship. The section representing the contents page and text matter is worthy of special attention. Many specimens submitted showed original ideas of treatment, and a high standard of technique. Great difficulty was found in adjudicating these sections.

It was rather disappointing to find a number of exhibits which could not in any way be interpreted as title pages. They were more in the nature of a commercial circular, printed in two or three colours. Those entering for these Competitions should make a study of title pages of a good standard.

There seems to be a general tendency to view the Competitions from the point of view of what is required in the publication of " special editions." Competitors should bear in mind the character of the book which they are producing. " Westward Ho ! " is essentially what may be called an ordinary or common novel, but only one competitor seemed to have had this point in view. In the contents pages some good examples were shown, but competitors should bear in mind the purpose of a contents page, which in all instances should be legible in its design and composition.

Some specimens were quite unsuitable for exhibition, and the notice of the competitors should be drawn to the rules of the Competition. In certain instances lay-outs were submitted, and others with hand work introduced. Such are ineligible. Further, it is not desirable that the same setting with an initial in a different colour should be submitted as a separate entry.

Competitors should understand the purpose of the Competition, which is for the improvement of book production. Originality of treatment is the main consideration. Many excellent examples were submitted, but frequently they were copies of well-known publications.

SUB-SECTION 4. *Drawings in black and not more than two tints of (a) a head-piece : (b) tail-piece ; (c) thumb-nail illustration, suitable to the size of the page.*

No awards were made in this Sub-Section.

Any head-piece or tail-piece must, above all things, be of a suitable weight for the type to produce a well-balanced page. All designs in future should be submitted with the type as a complete page or opening.

The Judges regret that no competitor has realised either the limitations or the possibilities of this section of the Competition, and they can make no awards nor recommend that any of the designs should be exhibited.

SUB-SECTION 5. *A case for a binding in either cloth or leather.*

The awards are as follows :—

A Prize of £2 2s. to Donald Bosher, Leicester College of Arts & Crafts. (No. 1753.)

Commended :

Charles Clifford Mitchell, Leicester College of Arts & Crafts. (No. 1752.)

Several candidates submitted designs for sides without backs as well. This should never be done, as sides and back form a complete whole.

" Leather working," although possibly suitable for blotters, is quite unsuitable for any practical form of book-binding.

The designs submitted were on the whole far too ornate, and most of them were unsuitable.

SUB-SECTION 6. *Designs for End-papers.*

The awards are as follows :—

A Prize of £6 6s. to Miss Katie McDonald, L.C.C. Central School of Arts & Crafts. (Nos. 2652 and 2653.)

A Prize of £3 3s. to Miss Joyce E. Gregory, Hornsey School of Art. (No. 2171.

Commended :

Miss Bertha J. Olyett, Press Art School, Forest Hill, S.E. (Nos. 1550 and 1551.

End-papers are used to join the cover and the text, and therefore should neither be obtrusive nor expensive to produce. It is advisable that they should not be pictorial and certainly not cut in half by the joint. The design by Miss Vera F. Fox (No. 2841) is a good drawing in this misdirection.

The wood-engraved end-papers (Nos. 2652 and 2653) are the most original submitted ; they are well drawn and suitable for their purpose. The second prize of £3 3s. is awarded to No. 2171. mainly for the wood-engraved design 3.

SUB-SECTION 7. *Designs for a Jacket.*

The awards are as follows :—

A Prize of £6 6s. to Miss Olive Francis Harris, Royal College of Art. (No. 524.)

A Prize of £3 3s. to Miss Doris Gully, Battersea Polytechnic School of Arts & Crafts. (No. 2271.)

Highly Commended :

Miss Daphne V. Barry, Battersea Polytechnic School of Arts & Crafts. (No. 2257.)
Miss Joyce Hall, Royal Albert Memorial School of Art, Exeter. (No. 555.)
Miss Katie McDonald, L.C.C. Central School of Arts & Crafts. (No. 2654.)

Commended :

Miss Margaret Blundell, Liverpool School of Art. (No. 2820.)
Miss Joyce H. Davies, Liverpool School of Art. (No. 2831.)
Miss Margaret E. Frere, Battersea Polytechnic School of Arts & Crafts. (No. 2267.)

William A. Wright, Battersea Polytechnic School of Arts & Crafts. (No. 2289.)

The Judges desire to point out that an essential part of the design of a book jacket is the title, etc. Many of the designs submitted avoided this important and difficult problem. Several, good as drawings, were rejected on the ground of unsuitability, while many were too expensive to reproduce. One design by Miss Gwendolen Jones (No. 2416) was more suitable for an end-paper and was accordingly transferred to that Sub-Section. Nos. 1559 and 1560 would make good window bills, but would be too expensive for book jackets.

SECTION V.—POTTERY AND GLASS.

A large number of designs for China and Earthenware were sent in, showing on the whole a good technical knowledge and generally a high standard of artistic taste. Unfortunately, the limits of space did not permit a large number to be exhibited so that it was necessary to set a rather high standard in making the awards, and in selecting designs for exhibition, and many designs had to be rejected for only minor faults.

Competitors from districts outside the Potteries area were obviously handicapped by their fewer chances of obtaining technical knowledge, and the Judges recommend to them a closer study of what is required in small essential details, such as thickness of handles on cups, size of foot to obtain a good stand, and adequate knobs on covers. These points can easily be observed on pottery in their own homes or in shop windows.

To those competitors from the Junior Department of the Burslem School of Art, we should like to offer words of encouragement. Their work is bright and shows distinct promise for the future.

SUB-SECTION I. (CHINA). *Design for a Cup and Saucer, Cream, and Bread and Butter Plate, with suitable decoration.*

The awards are as follows:—

A Prize of £5 5s. to each of the following :
Miss Catherine M. Brown, Watford School of Art. (No. 1898.)
William Ruscoe, Stoke Art School. (No. 1372.)

Commended :

Mrs. Inez Batterbury, Blackheath School of Art. (No. 342.)
Miss Freda M. Beardmore, Burslem Art School (Junior Dept.) (No. 2467.
Roy S. Durber, Burslem Art School (Junior Dept.) (No. 2502.)
Fred V. Moore, Burslem School of Art. (No. 2449.)
Miss May Mountford, Hanley School of Art. (No. 2189.)
Miss Millicent J. Taplin, Hanley School of Art. (No. 2200.)

A large amount of really good work was shown in this Sub-Section, the Judges only arriving at their decisions after carefully weighing up the technical as well as the artistic points.

† Design for a Cup and Saucer, Cream Jug and Bread and Butter Plate, by Miss Catherine M. Brown.

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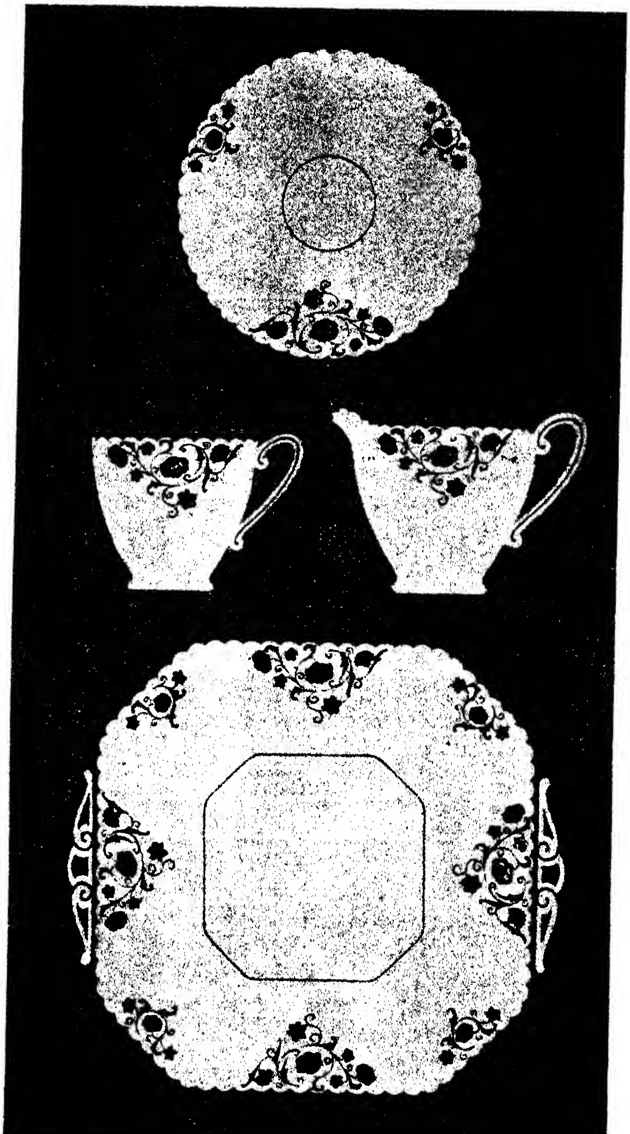

† Design for a Cup and Saucer, Cream Jug and Bread and Butter Plate by William Ruscoe.

Designs Nos. 1898 and 1372 were finally chosen as being of equal merit. No. 1372 is a technically correct design, well drawn and finished. No. 1898 has a freshness which appeals. One small point recommended to the designer is that the cream jug is a little unfinished at the top. Both look like saleable designs.

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No. 342 is a pretty design using heather as a motive, while Nos. 2502 and 2476 are both good. No. 2449 would make an attractive children's set, but is not so good for a general tea set.

Nos. 2052-7 (John Buchanan, City of Oxford School of Art), are very well drawn, but technically not sound; the narrow borders are probably too miniature and complex, whilst the heraldic lion design would be extremely difficult to apply to the tea cup or jug. We recommend this designer to try the effect of bending a piece of thin tracing paper round a shape such as the cup he shows; he would find too many creases occurring in the paper.

SUB-SECTION 2 (CHINA). *Design for a practical shaped Teapot, with suitable decoration.*

The awards are as follows:

A Prize of £5 5s. to William Ruscoe, Stoke Art School. (No. 1374.)

Commended:

Albert Capey, Burslem Art School (Junior Dept.) (No. 2491.)

William Hargreaves, Burslem Art School (Junior Dept.) (No. 2520.)

George Tams, Burslem Art School (Junior Dept.) (No. 2587.)

Some competitors placed the spout too high, which would allow the tea to pour over the top of the pot before coming out of the spout, or too low, which would not allow the pot to be filled before running out of the spout. Some made the knob on the cover so small that it would hardly serve its purpose, or would easily be knocked off.

No. 1374 was selected for an award, because it most satisfied requirements. It was well drawn, with capable handle and knob and with steady base, and would not upset easily.

Others, such as Nos. 2480-2491, would make good teapots for café or restaurant use, being strong in the handle and spout, but knobs are generally too small or weak.

SUB-SECTION 3 (EARTHENWARE). *A Dinner Plate and Vegetable Dish, of simple design, with suitable decoration.*

The awards are as follows:—

Highly Commended:

Miss Doris Parton, Hanley School of Art. (No. 2191.)

Miss Millicent J. Taplin, Hanley School of Art. (No. 2201.)

Many really good designs were shown, but some were spoiled by the shape of the vegetable dish. Some competitors made it so shallow that it could be better used as a bacon dish than for vegetables. Others made the knob on the cover too thin at the contact point, or much too small for the grip.

Nos. 2191 and 2201 are both well drawn designs and are highly commended.

SUB-SECTION 4 (EARTHENWARE). *A Vase, not more than 12in. in height, with decoration suitable for either China or Earthenware.*

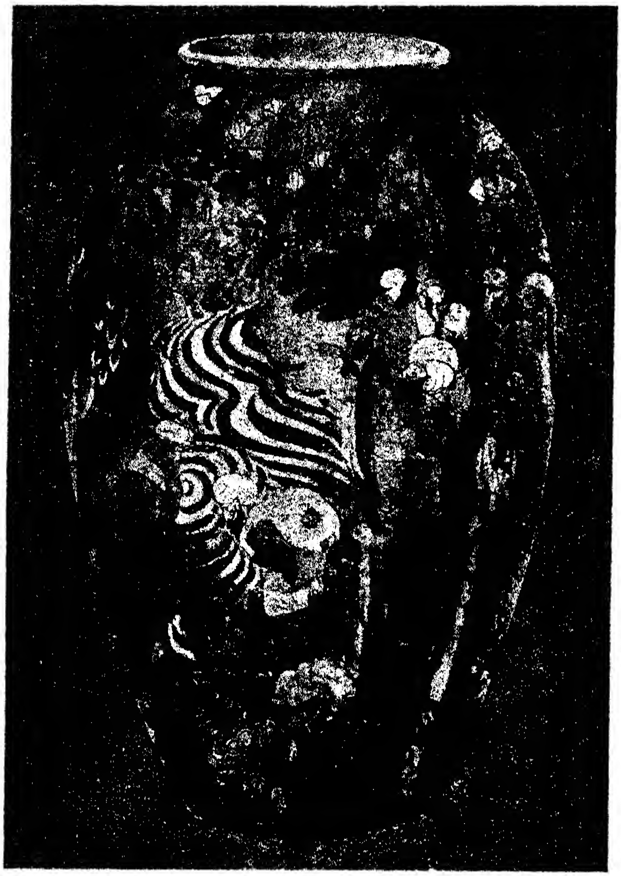
The awards are as follows:—

A Prize of £5 5s. to Miss Doris Parton, Hanley School of Art. (No. 2196.)

Commended :

Mrs. Inez Batterbury, Blackheath School of Art. (No. 345.)
Albert W. Nixon, Burslem Art School (Junior Dept.) (No. 2555.)
Victor G. Skellern, Hanley School of Art. (No. 2199.)
Miss Millicent J. Taplin, Hanley School of Art. (No. 2202.)

This Sub-Section is, perhaps, the weakest in the pottery designs, though some good designs are shown. Some competitors do not seem to realise that a vase should have



† Design for a Vase, by Miss D. Parton.

a foot wide enough to allow it to stand without being easily pushed over. Others have shown the design as if it was for a flat surface instead of a round base, lines sometimes not following the contour but coming straight down.

No. 2196 was finally chosen as showing the most originality.

To conclude : Many of the competitors show by a general similarity of design that " the factory " has had a large influence on the styles produced. To these we would recommend more study of the best pottery in Museums, to try to get more variety, by using other methods of producing artistic results, thus widening their technical knowledge and perhaps attaining newer effects than those with which they are immediately surrounded in the factory.

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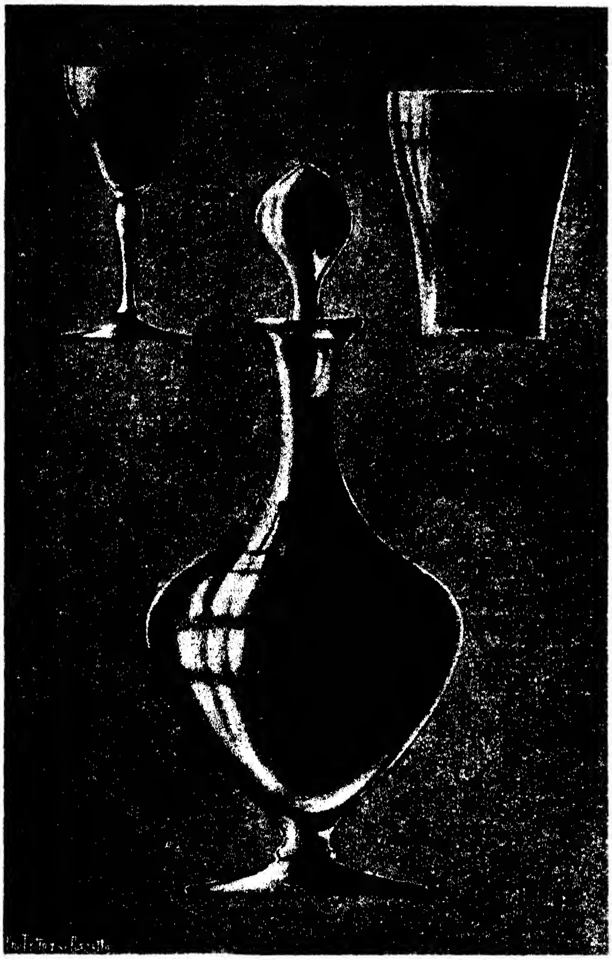

† Design for a Wine-glass, a Tumbler and a Decanter by Leonard Green.

SUB-SECTION 5. (GLASS). *A Service of Glass (i.e., a Wine Glass, a Tumbler and a Decanter) of good form, with or without decoration.*

The awards are as follows :—

A Prize of £10 10s. to Leonard Green, Wordsley School of Art and Technical Institute. (Nos. 1936 and 1938.)

SUB-SECTION 6. (GLASS). *A Centre Piece for table decoration, not exceeding 9in. in height, with decoration suitable for cutting, and Vases to match.*

The awards are as follows :—

A Prize of £10 10s. to Leonard Green, Wordsley School of Art & Technical Institute. (No. 1933.)

Highly Commended :

Leonard Green, Wordsley School of Art and Technical Institute. (Nos. 1931, 1932, 1934, and 1935.)

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The designs submitted were disappointing both in number and in originality. The Judges cannot understand why wider interest is not taken in the glass district and why students do not try to strike out more original ideas. The designs exhibited are of the type that one can see in nearly every trade catalogue. The designs sent in by Leonard Green stand out as the best in Sub-Sections 5 and 6

Section VI.—Miscellaneous.

Sub-Section 1. *Prizes offered by the Empire Marketing Board for a Design for a Shop Window Bill.*

The awards are as follows :—

The First Prize of £25 and the Second Prize of £10, are divided equally between
Miss Nita Worth, Bournemouth School of Art. (No. 2124)
William Grundy, Halifax School of Art. (No. 1993.)

The Third Prize of £5 to Michael L. P. Reilly, Elmhurst, Lichfield Road, Four Oaks, near Birmingham. (No. 241.)

Commended :

Miss Astrid Barlow, Manchester Municipal School of Art. (No. 2692.)
Miss Kathleen M. Cooper, Nottingham School of Art. (No. 2936.)
Miss Phyllis Jones, Sheffield College of Arts and Crafts. (No. 2146.)
Eric Moss, Liverpool School of Art. (No. 2867.)
Raymond V. Robert, 16, Chinley Avenue, Moston, Manchester. (No. 687.)

In the opinion of the Judges, Nos. 1993 and 2124 are of equal merit, and the first and second prize are divided equally between them. The quality of the workmanship in No. 2124 is equalled by the clarity of No. 1993. The third prize of £5 is awarded to No. 241 for the originality of the design and the treatment of the pictorial portion. The lettering, both in placing and execution is not sufficiently good. No. 2936 is commended for its poster qualities, but the drawing is crude and lacking in quality. No. 2692 is commended for originality of design. The lettering, however, is poor and inconspicuous. No. 687 is commended for its lettering. No. 2867 is commended for its ingenuity, but is somewhat spoilt by its colouring. No. 2146 is disqualified for not conforming to the regulations, but is commended as having merit.

Sub-Section 2. *Prize offered by Messrs. Simpson and Godlee, Ltd., for design for a Poster advertising "Bevis Fabrics."*

The Prize of 50 guineas was divided and awarded as follows :

A Prize of £21 to Charles Dean, Liverpool School of Art. (No. 2833.)

A Prize of £15 15s. to each of the following :

Miss Amy Ayres, Wick Studio, Hove. (No. 1966.)
McKean E. Tatchell, 135, Upton Park Road, Forest Gate, E.7. (No. 1453.)

Highly Commended :

Miss Barbara Beaumont, Brighton Municipal School of Art. (No. 1196.)
Miss D. Bullock, King Edward VII School of Art, Newcastle-on-Tyne. (No. 7.)
Miss G. M. Dickinson, L.C.C. Hammersmith School of Arts and Crafts. (No. 2073.)
Miss Winifred Forgan, L.C.C. Central School of Arts and Crafts. (No. 849.)
Miss Marjorie Kershaw, Liverpool School of Art. (No. 2858.)
John Gordon Smith, Manchester Municipal School of Art. (No. 2778.)

Commended:

Sydney Arrobus, 50, Guilford Street, W.C.1. (No. 349.)
Francis M. Baker-Smith, Cambridge University School of Architecture. (No. 252.)
Miss Agnes Duguid, International Correspondence Schools, Kingsway, W.C.2. (No. 1251.)
Miss Anne Gilchrist, Grosvenor School of Modern Art, 33, Warwick Square, S.W. (No. 1554.)
Miss Olive F. Harris, Royal College of Art. (No. 525.)
Miss M. O. Lilley, Battersea Polytechnic School of Arts and Crafts. (No. 2275.)
Miss Barbara Stubbs, Royal College of Art. (No. 2994.)

There was a gratifying number of entries for these prizes, and the best of them reached a good standard of excellence, although there was not a great deal of originality of ideas.

The Judges felt that there was nothing of such outstanding merit as to justify the award of the fifty guineas in one prize, and they have divided the amount as shown above.

SUB-SECTION 3. *Prize offered by Messrs. C. C. Wakefield & Co., Ltd., for Poster or Showcard advertising Wakefield Castrol Motor Oils.*

The Judges were unable to recommend that the full prize of £50 should be given, but the following awards were made:—

A First Prize of £20 to Dr. John Duguid, 13, Manor Place, Cults, Aberdeen. (No. 1254.)
A Second Prize of £15 to Francis H. Bramwell, Sheffield College of Arts and Crafts. (No. 2130.)

Three equal Prizes of £5 each to
Henry W. Collins, Colchester School of Arts and Crafts. (No. 1557.)
Arthur Morrison, Liverpool School of Art. (No. 2866.)
William Southon, Manchester Municipal School of Art. (No. 2780.)

Highly Commended:
Miss May Bilbie, Nottingham School of Art. (No. 2918.)
Joseph P. McCrum, Royal College of Art. (No. 1316.)

Commended:
Robert H. Fraser, Dunedin School of Art, New Zealand. (No. 2600.)
Harry Helliwell, Halifax School of Art. (No. 2001.)
Frederick G. Osborne, Margate School of Art. (No. 1814.)

This competition brought forth very little of real originality. Many of the designs were reproductions of well-known themes, while others had only the merit of their technique.

SUB-SECTION 4. *Prize offered by Henley's Tyre & Rubber Co., Ltd., for Design for a Poster advertising the Company's Pneumatic Motor Tyres.*

The Judges recommend that the £50 Prize should be divided and three Prizes of £16 16s. each awarded to the following:—

Thomas S. Burrows, Nottingham School of Art. (No. 2922.)
Geoffrey L. Rudd, Nottingham School of Art. (No. 2957.)
Noel Syers, Goldsmiths' College School of Art (University of London). (No. 1071.)

Commended :

Cecil Cooke, Alcourt, Sandy Lane, Cheam, Surrey. (No. 22.)
Eugene Fancott, Liverpool School of Art. (No. 2840.)
Miss Doris Gully, Battersea Polytechnic School of Arts and Crafts. (No. 2273.)
John Nicolson, 16, Uffington Road, S.E.27. (No. 1343.)
Frank H. Pavely, L.C.C. Hackney Technical Institute. (No. 225.)
Roland Wigginton, 144, Hertford Road, De Beauvoir Town, N.1. (No. 419.)

It is recognised that the subject set is difficult, but the Judges found the level of originality low and the technique in a large proportion of the entries rather poor. The prize was divided because not one sketch showed sufficient originality of idea or treatment to justify the award of the full prize. The entries commended were commended for "Workmanship," rather than for originality or advertising value.

SUB-SECTION 5. *Prize offered by Messrs. W. T. Henley's Telegraph Works Co., Ltd., for a Design for a Showcard advertising the Henley Wiring System.*

The Judges were unable to recommend that the full Prize of £25 should be given, but a Prize of £10 was awarded to

Percy Bamberger, "Broadway," Chapel Lane, Frodsham, Cheshire. (No. 159.)

This competition attracted only eight entries, not one of which fulfils the requirements of the competition. None of the designs would make a showcard suitable to "*Advertise the Henley Wiring System.*" In most cases the entrants have a wrong idea of what is wanted, and have submitted designs which have no reference to the electric wiring of buildings. Telephones, Telegraph Wires and Switches have been introduced. The subject is probably a difficult one, and in a future competition the donors will give an outline of the requirements for a showcard for the subject. Mr. Bamberger's design came nearest to the object to be secured.

SUB-SECTION 6. (1) *Prizes offered by Messrs. J. S. Fry & Sons, Ltd., for a Poster advertising Fry's Breakfast Cocoa.*

The awards are as follows :—

A First Prize of £10 10s. to Frederick B. Hayes, Bath School of Art. (No. 945.)
A Second Prize of £7 7s. to Miss Edna Oakden, Manchester Municipal School of Art. (No. 2756.)
A Third Prize of £5 5s. to George F. Lunt, Liverpool School of Art. (No. 2862.)

Highly Commended :

Miss Mary Caine, Nottingham School of Art. (No. 2927.)
Frank Hilton, International Correspondence Schools, Kingsway, W.C.2. (No. 952.)
Daniel McKay, c/o Wallace, 19, Langside Road, Glasgow, S.2. (No. 1019.)

Commended :

Stanton H. Elliott, Liverpool School of Art. (No. 2837.)

The majority of competitors do not seem to have realised that the purpose of a poster is to give a message in a flash. They ought to keep in view that confusion in design and lettering destroys the value of a design as a poster. The three winning designs are thoroughly competent both in design and colour.

SUB-SECTION 6. (2) *Prizes offered by Messrs. J. S. Fry & Sons, Ltd., for a Design for a Showcard advertising Fry's Easter Eggs.*

The awards are as follows : -

A Prize of £10 10s. to Leonard Towers, Liverpool School of Art. (No. 2897.)
A Prize of £7 7s. to Miss Mary Caine, Nottingham School of Art. (No. 2929.)
A Prize of £5 5s. to Fred Clay, Bradford College of Arts and Crafts. (No. 2020.)

Highly Commended :

Harold Hemingway, Rochdale School of Art. (No. 1837.)
Miss Jennie Whitham, Leeds College of Art. (No. 1681.)

Commended :

Miss Molly Chilton-Price, Bath School of Art. (No. 637.)
Miss Gladys Rees, West Deeping, near Peterborough. (No. 207.)

This work as a whole was rather disappointing, owing to its lack of simplicity. Competitors in this Sub-Section should remember that the function of a window showcard is simply to direct attention to the goods near which it is placed amongst competing attractions.

SUB-SECTION 7. (1) *Prizes offered by Messrs. W. McKenzie & Co., Ltd., for Designs for Christmas Cards.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £10 to Henry W. Wallwork, "Netherleigh," Middlewich Road Holmes Chapel, Cheshire. (No. 1138 (b).)

A Prize of £5 for each design to the following :

Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol. (Nos. 2672 and 2673.)
Miss Marian Peck, Sheffield College of Arts and Crafts (Nos. 2151 and 2152.)
Miss Isabel Saul, Bournemouth School of Art. (No. 2122.)

A Prize of £3 to Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol. (No. 2675 (a)).

A Prize of £2 for each design to the following :

Miss Kathleen Atkins, Royal College of Art. (Nos. 1184 (d) and 1184 (f)).
Miss Berenice Butler, Popplestones, Trimley St. Mary, Ipswich, Suffolk. (Nos. 429 and 431.)
Miss Joyce Mercer, 13, Ranmoor Park Road, Sheffield. (No. 219.)
Miss Mary Mordle, Nottingham Correspondence College for Applied Designs (No. 1806 (a)).

The competition as a whole was interesting, but there were not three outstanding designs to merit award of prizes as originally offered. The prize money, therefore, was divided amongst the best as shown above.

SUB-SECTION 7. (2) *Prizes offered by Messrs. W. McKenzie & Co., Ltd., for Designs for Fancy Calendars.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £5 5s. to each of the following :

Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol. (No. 2676.)
Raymond V. Robert, 16, Chinley Avenue, Moston, Manchester. (No. 680.)

A Prize of £3 3s. to each of the following:

John Buchanan, Oxford School of Art. (No. 2059.)
Miss Marjorie Carter, Leeds College of Art. (No. 1666.)
Miss Marianne Edwards, 78, Onslow Gardens, Muswell Hill, N.10. (No. 38.)

The competition fell entirely short of its aim, and it was impossible to award the maximum prizes. The above designs, however, have some merit.

SUB-SECTION 8. *Prizes offered by Messrs. Hodder & Stoughton, Ltd., for three Hodder & Stoughton Designs for advertisements in the Press.*

(1) *Design for Novels.* (2) *Design for General Books.* (3) *Design for Religious Books.*

The Judges were unable to recommend that the three full Prizes of £5 5s. should be given, but the following awards were made:—

A Prize of £3 3s. to Thomas H. Jenkin, A.R.C.A., 3, Stafford Street, Dunedin, New Zealand. (No. 212.)

A Prize of £2 2s. to each of the following:

James L. Carstairs, 15d, Avonmore Road, W.14. (Nos. 61 to 63.)
Brian M. Gilks, International Correspondence Schools, Kingsway, W.C. (No. 93.)

Highly Commended:

Miss Mary Caine, Nottingham School of Art. (No. 2931.)
Richard Mallett, Lowestoft School of Art. (No. 1789.)

Commended:

Bernard Griffin, 40, Roland Road, Handsworth, Birmingham. (Nos. 513 to 516.)

The competitors have not grasped the purpose of this competition. Most of the designs incorporate hackneyed symbols, and, with few exceptions, shew no original conceptions, and have not grasped the initial commercial requirements. In the religious designs competitors have failed to appreciate the need for catholicity of expression.

SUB-SECTION 9. *Prize offered by Messrs. Catesbys, Ltd., for a Design for a Booklet Cover of Catesbys' Cork Lino.*

The awards are as follows:—

A Prize of £7 7s. to George F. Yarnell, 450, Upper Richmond Road, Richmond, Surrey. (No. 1171.)

A Prize of £3 3s. to Miss Violet Stacey, Letchworth C.C. Elementary School. (No. 705.)

Commended:

Arthur J. Cooper, 64, Grove Avenue, Twickenham, Middlesex. (No. 789), for novelty of idea in the method of display.
Miss Honor Howard-Mercer, Guildford School of Art. (No. 979.)

All the designs submitted were creditable, and the candidates appear to have grasped the main ideas of the competition.

SUB-SECTION 10. (1) *Prizes offered by Messrs. Joseph Nathan & Co., Ltd., for a Design advertising Glaxo or Glax-ovo.*

The awards are as follows :—

A First Prize of £25 to George H. Tomlinson, Manchester Municipal School of Art. (No. 2787.)

A Second Prize of £5 5s. to Miss Barbara Shipley, Nottingham School of Art. (No. 2962.)

Highly Commended :

Miss Eleanor M. East, Brighton Municipal School of Art. (No. 47.)
Miss Barbara Shipley, Nottingham School of Art. (No. 2960.)

Commended :

George H. Tomlinson, Manchester Municipal School of Art. (Nos. 2785, 2786, and 2788.)

George H. Tomlinson's design (No. 2787) was selected for first prize because it shews what the food does or the result from taking it. In contrast, No. 47 shows what the food is composed of. The bulk of people are influenced to purchase a food by results; if, however, they were purchasing a motor car or an incubator, mechanical details of construction would be important. For instance, with a baby food, most mothers have not the knowledge of what a baby food should be, nor have they much knowledge of what a baby should have; this is also true of adults. That Glaxovo is composed of highly nutritive constituents, easily digested, quickly prepared, is not as strong a selling point as that it will provide sleep for the sleepless, feed jangled and starved nerves, or provide a quickly prepared supper dish. In effect, what the food does is the primary sales point ; what it is composed of the secondary one, and this has been the fundamental basis on which the Judges have made their selection.

SUB-SECTION 11. *Prizes offered by Messrs. Rowntree & Co., Ltd., for a Window Display Piece.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £10 to Harold Kenneth White, Blackheath School of Art and Crafts. (No. 1465.)

A Prize of £5 to Miss Daphne Barry, Battersea Polytechnic School of Arts and Crafts. (No. 2256.)

Commended :

Miss Grace M. Hawkins, "Ravenhurst," Westgate-on-Sea, Kent. (No. 920.)

In connection with the design for a Window Display Piece, the two previous Competitions proved to be more or less in the nature of an educational period in so far as this section of art work was new to most students. This year a large number of applications was received for references and photographs, and it was anticipated that an increased number of designs would be submitted, but this was not the case, and 20 only were received. The designs this year were a little better than in previous years, but no entry merited first prize. The Judges, however, awarded consolation prizes as shown above.

GENERAL NOTE.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH—BUILDING RESEARCH—BULLETIN No. 5—THE PROPERTIES OF BREEZE AND CLINKER AGGREGATES AND METHODS OF TESTING THEIR SOUNDNESS.—Since the publication more than a year ago, of a report upon the general properties of breeze and clinker and their use as concrete aggregates, work has been in progress at the Building Research Station on the causes of failure experienced with concrete made with these materials. In this Bulletin a survey of these causes is presented in non-technical language, and two simple methods of testing the soundness of breeze and clinker aggregates are given. These tests have been designed for use on the job, without the aid of laboratory apparatus. It is hoped that these tests may help to minimise failure and to assist the builder to select and use with confidence a cheap material, which, if free from harmful constituents, possesses properties which make it suitable for a number of purposes. A complete account of the investigations upon which this Bulletin is based will be published as a separate technical paper. The Bulletin may be obtained, price 6d. (postage extra), from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2, or through any bookseller.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 17..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Mr. Basil Ionides, "Modern Glass."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Papers to mark the Bicentenary of Captain Cook, including an appreciation of his life written by Sir Henry Newbolt.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. J. R. Duggan, "Suction Gas as an Automobile Engine Fuel."

North-East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne. 7.15 p.m. Mr. John Neill, "Could the Method of Conducting Measured Mile Trials be Improved?"

University of London, at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen. Sir Frederick Maurice, "Allenby's Campaigns in Palestine." (Lecture II).

TUESDAY, DECEMBER 18..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Miss R. M. Fleming, "A Study of Growth in Children: its Ethnological and Educational Significance. An Analysis of Six Years' Consecutive Measurement."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. J. H. Nicholson, "The Reconstruction of the New Holland Pier."

Heating and Ventilating Engineers, Institution of, at Milton Hall, Deansgate, Manchester. 7 p.m. Mr. A. B. Crompton, "Drying in Laundries."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. Charles Eastwood, "Corsica. Napoleon's Beautiful Island Home."

Mechanical Engineers, Institution of, at the Queen's Hotel, Birmingham. 6.30 p.m. Dr. H. W. Swift, "Power Transmission by Belts: An Investigation of Fundamentals."

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Mr. H. E. Soper, "The Interpretation of Periodicity in Disease Prevalence."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. H. J. Butler, "Commercial Motor Vehicles, their Varieties and Uses."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. A. Drysdale Wilson, "The Elimination of Street Accidents."

WEDNESDAY, DECEMBER 19..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. I. W. G. Freeman, "The Harbour Improvement Scheme at St. Peter Port, Guernsey."

Electrical Engineers, Institution of, at the Cleveland Technical Institute, Middlesbrough. 7 p.m.

Geological Society, Burlington House, W. 5.30 p.m. Prof. W. J. Pugh, "The Geology of the District between Llan-y-Mawddwy and Llanuwchllyn."

Mechanical Engineers, Institution of, at the Technical School, Lincoln. 6.30 p.m. Mr. H. R. Ricardo, "Internal-Combustion Engines."

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. (1) Mr. L. H. G. Dines, "The Dines Float Barograph"; (2) Dr. J. Glasspoole, "The Distribution of the Average Seasonal Rainfall over Europe."

Microscopical Society, 20, Hanover Square. 7.30 p.m. (1) Messrs. E. Heron-Allen and A. Earland, "Some Further Notes on the Pegididæ"; (2) Prof. E. Ghosh, "A New Parasitic Ciliate from the Intestine of the Bengal Monkey (*Macacus rhesus*)."

THURSDAY, DECEMBER 20..Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. C. K. Ingold and C. N. Vass, "Influence of Poles and Polar Linkings on the Course Pursued by Elimination Reactions. Part II. Mechanism of Exhaustive Methylation." (continued). (2) Messrs. G. W. Fenton and C. K. Ingold, "Influence of Poles and Polar Linkings on the Course pursued by Elimination Reactions. Part III. A Decomposition of Dialkylsulphones." (3) Messrs G. T. Morgan and R. A. S. Castell, "Researches on Residual Affinity and Co-ordination. Part XXXI. Molybdyl bis-β-diketones." (4) Messrs. G. T. Morgan and F. H. Burstall, "Interactions of Selenium Oxychloride and Phenols." (5) Messrs. C. K. Ingold and E. Rothstein, "Influence of Poles and Polar Linkings on Tautomerism in the Simple Three-Carbon System. Part I. Experiments illustrating Prototropy and Anionotropy in Trialkylpropenylammonium Derivatives." (6) Mr. S. Sugden, "The Parachor and Chemical Constitution. Part X. Singlet Linkages in Chelated Coordination Compounds."

Electrical Engineers, Institution of, Savoy Place, W.C. 5.30 p.m. Commemoration of the Jubilee of the Incandescent Electric Lamp. Lecture by Mr. James Swinburne, F.R.S., on Sir Joseph Swan's work.

6 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

Mechanical Engineers, Institution of, at the Queen's Hotel, Birmingham. 6.30 p.m.

At the Engineers' Club, Manchester. 7.15 p.m. Mr. E. G. Herbert, "Machinability."

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

At the Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "Bernini and the XVIIth Century."

FRIDAY, DECEMBER 21..British Electrical Development Association, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Mr. J. E. Tapper, "Hire and Hire Purchase in Electrical Development Schemes."

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Mr. Paul Edmonds, "Burma and the Burmese."

University of London, at the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odložilík, "England and Bohemia." (Lecture III).

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3970. VOL. LXXVII.

FRIDAY, DECEMBER 21st, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows :—

LECTURE I—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

COUNCIL.

A meeting of the Council was held on Monday, December 10th. Present :— Sir George Sutton, Bt., in the Chair ; Sir Charles H. Armstrong ; Sir Atul C. Chatterjee, C.I.E. ; Sir Alexander Gibb, G.B.E., C.B. ; Mr. John S. Highfield,

M.Inst.C.E., M.I.E.E. ; Col. Sir Arthur Holbrook, K.B.E., M.P. ; Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S. ; Major Sir Humphrey Leggett, R.E., D.S.O. ; Sir Philip Magnus, Bt. ; Sir Francis G. Ogilvie, C.B., LL.D. ; Mr. Alan A. Campbell Swinton, F.R.S. ; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society :—

Bradby, Anthony Strudwicke, London.
Brice, Edward Kington, Ashton-under-Hill, Nr. Evesham.
Brown, Henry J., London.
Burgess, Edward Elman, Leeds.
Clift, Sidney, Bloxwich, Staffs.
Fisher, Ernest Arthur, M.A., D.Sc., St. Albans.
Ganguli, S., Baroda, India.
Hilditch, John, Manchester.
Hipwell, Miss Hermine Hallam, London.
Holmes, Kenneth, London.
Hopley, John Woodrow, London.
Law, A. Francis, M.B., B.Sc., Kuching, Sarawak.
Logsdail, William, Noke, Nr. Islip, Oxford.
Marjoribanks, Sir George John, K.C.V.O., London.
Morley, Cyril, Bakewell, Derbyshire.
Pledger, Robert Howland, B.Sc., Ewell, Surrey.
Poland, Eustace Bernard, Worthing.
Rhys-Jenkins, Lieut.-Colonel Griffis W., London.
Rosenblatt, Maurice C., Philadelphia, Pa., U.S.A.
Ross, Victor, Toronto, Canada.
Rundell, John William, Rochester, Kent.
Ryland, Alfred Samuel, A.R.C.A., Loose, Nr. Maidstone.
Sellers, Horace Wells, B.Sc., Philadelphia, Pa., U.S.A.
Slipper, Harold Frederick, Harston, Cambs.
Smart, Borlase, R.O.I., R.W.A., Salcombe, Devon.
Smith, Hely A. M., R.B.A., London.
Tilling, E. W., Bromley, Kent.
Tomlins, William Edward, Tutye, Victoria, Australia.
Wren, Henry, Oxshott, Surrey.

The Report of the Departmental Committee on Examinations for Part-Time Students was further considered.

A letter from the Gloucestershire Rural Preservation Committee was read congratulating the Society on their action in purchasing for permanent preservation the group of cottages known as Arlington Row, Bibury.

Dr. P. M. Evans, LL D., was appointed to represent the Council on the Chadwick Trust, in place of Sir Frank Baines, K.C.V.O., C.B.E., resigned.

The Chairman of the Council, Sir William Davison, K.B.E., D.L., M.P., Sir Philip Magnus, Bt., and Mr. A. A. Campbell Swinton, F.R.S., were appointed to represent the Council on the Joint Committee of the Royal Society of

Arts and the Royal College of Physicians to consider the award of the Swiney Prize for the best published work on Medical Jurisprudence.

The Chairman of the Council, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., Mr. J. S. Highfield, M.Inst.C.E., M.I.E.E., the Hon. Sir Charles Parsons, O.M., K.C.B., D.Sc., F.R.S., Mr. James Swinburne, F.R.S., and Mr. A. A. Campbell Swinton, F.R.S., were appointed as a committee to examine the Report on the British Patent System, prepared under the auspices of the British Science Guild.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

SIXTH ORDINARY MEETING.

Wednesday, December 12th, 1928. Sir Oliver J. Lodge, M.A., LL.D., D.Sc., F.R.S., in the Chair.

A paper on "Applications of Electricity to Medical Practice," was read by Mr. G. G. Blake, M.I.E.E., F.Inst.P. The paper and discussion will be published in the *Journal* on January 18th.

DOMINIONS AND COLONIES SECTION.

Friday, December 14th, 1928. Dr. Arthur William Hill, C.M.G., Sc.D., F.R.S., F.L.S., in the Chair.

A paper on "The Improvement of Negro Agriculture," was read by the Right Hon. Lord Olivier, P.C., K.C.M.G., C.B., LL.D. The paper and discussion will be published in the *Journal* on January 25th.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Monday, December 3rd, 1928.

Sir Reginald A. Mant, K.C.I.E., C.S.I. (Member of the India Council), in the Chair.

The Chairman said that Sir James MacKenna possessed special qualifications to deal with the subject of his lecture. Sir James had been for many years Agricultural Adviser to the Government of India, and President of the Agricultural Research Institute at Pusa—an Institute which had done such wonderful work for Indian agriculture. Recently he had been a member of the Royal Commission on Agriculture in India. In addition to his general knowledge of agricultural conditions in India, Sir James had taken a special interest in the question of sugar

production, and it had been largely at his instance that a Committee had been appointed by the Government of India in 1918 to go into this question. Sir James had been appointed Chairman of that Committee. Unfortunately, other duties had called him away before the Committee's labours were finished, but the audience that evening would find that he had continued to take an interest in the subject.

The following paper was then read:—

THE INDIAN SUGAR INDUSTRY.

By Sir James MacKenna, C.I.E.

I think I may modestly claim that the last word on Indian sugar was said in the report of the Indian Sugar Committee, of which I was the original President. What, therefore, I say to you this afternoon may have a very strong resemblance to the report of that Committee. And, after its exhaustive examination of the subject in all its aspects, there is little new to add. But a general survey of the position in a somewhat shorter compass than that of the report may, I hope, serve to give an impression of the sugar industry of India which may be of interest.

The Origin of Sugar Cane.

Prinsen Geerligs, whose book, "The World's Cane Sugar Industry, Past and Present," is probably the most authoritative work on the subject, gives it as his opinion that in all probability the sugar cane originally came from India, more especially from the banks of the Ganges. He adds, however :—

"We cannot be absolutely certain of this, as at the present day tropical sugar cane in its wild state is not found anywhere.

"The probability, however, of its originating from India is very strong, as only the ancient literature of that country mentions sugar cane, while we know for certain that it was conveyed to other countries by travellers and sailors.

"According to Hindu mythology, sugar cane was created by the famous hermit Vishva Mitra to serve as heavenly food in the temporary paradise which was organised by him for the sake of Raja Trishanku. This prince had expressed his wish to be translated to heaven during his lifetime, but Indra, the monarch of the celestial regions, had refused to admit him. In order to meet his wish, Vishva Mitra prepared a temporary paradise for him, but when a reconciliation between the two rajas was brought about, the paradise was demolished and all its luxuries destroyed except a few, including sugar cane, which was spread all over the land of mortals as a permanent memorial of Vishva Mitra's miraculous deeds.

"The fellow-travellers of Alexander the Great, and afterwards writers who made use of their notes, tell us of a reed growing in India which produced honey without the aid of bees. We also find sugar cane repeatedly mentioned as a tribute to the Emperor of China from the Indian border provinces, which also accounts for sugar cane having spread as far as the East.".

BOTANICAL.

It seems hardly necessary in a paper of this kind to go deeply into the botany of sugar cane, a subject which has been very thoroughly investigated by many workers. Suffice it to say that the true sugar cane all belongs to the genus *Saccharum*, and of the numerous sub-genera only *S. Officinarum* and *S. Spontaneum* are true sugar canes. Of these, *S. Spontaneum* occurs abundantly in the wild state in India and other parts of Southern Asia and in many of the Pacific Islands. According to Barber, who has studied the wild forms carefully and used them for crossing on cultivated kinds, this is an exceedingly variable species. The evidence is conclusive that the slender cultivated kinds of Northern India (including *Uba*, which attracted so much attention in Porto Rico because of its immunity to mosaic diseases) are nothing more than selected forms of this wild species.

S. Officinarum was founded by Linnaeus on the cultivated thick-stemmed tropical sugar canes. It has always been held that this constituted a distinct species, but no wild representative of it has ever been found. It seems not improbable that all cultivated sugar canes, both thick and thin stalked varieties, may, in fact, be descendants of the wild *S. Spontaneum*.

ACREAGE UNDER CANE.

The five-yearly average of acreage under cane for the periods 1890-01 to 1924-25 and the annual average of the last three years in India are as follows :—

1890–91	to 1894–95 ...	... ...	2,863,400 acres
1895–96	,, 1899–1900	... ...	2,735,400 ,,
1900–01	,, 1904–05 ...	... ...	2,375,600 ,,
1905–06	,, 1909–10 ...	... ...	2,385,000 ,,
1910–11	,, 1914–15 ...	... ...	2,511,000 ,,
1915–16	,, 1919–20 ...	... ...	2,794,800 ,,
1920–21	,, 1924–25 ...	... ...	2,794,800 ,,
1925–26	,, 1927–28 ...	... ...	2,950,000 ,,

A study of these figures shows that from 1900 to 1914, when cheap imports of foreign sugar were pouring into India, the area under sugar cane showed contraction, while from 1914 onwards, as a result of the War and its after-effects, imports became more difficult, sugar rose in value, and the area under cane in India increased.

Another point that emerges from these average figures is that, although the population in India has increased enormously during the last three decades, the area under sugar cane, from which the requirements of the country in the matter of *gur* or *jaggery* can be met, has only recently overtaken the acreage in the nineties. Meanwhile, the imports of foreign sugar have more than quadrupled. We have no reason to believe that there has been any appreciable increase in the amount of *gur* obtained from this acreage, and the inference would seem to be either that the consumption of *gur* per head of the population

is falling off or else that a large number of people do not consume *gur*, but use imported refined sugar. But even if this assumption is correct the annual consumption of *gur* is enormous. In his presidential address in the section of agriculture at the Indian Science Congress this year Rao Bahadur Venkataraman, the present sugar cane expert, analysed the Indian consumption of sugar and its products as follows :—

> "The annual consumption of *gur* and sugar combined is roughly a little over three and a quarter million tons, of which about 75% consists of *gur* and country sugar. Of the remaining 25% about 3-4% is crystal sugar, home-made in more or less modern factories and refineries working in this country. The remainder, that is, between 21-22%, has to be imported each year from outside, chiefly from Java, at a total cost of about fifteen crores of rupees."

In view of this position it is clear that the claims of improved *gur* manufacture must figure prominently in any scheme for the betterment of the Indian sugar industry. Research work is necessary to place this cottage industry on a proper and less wasteful basis, for it is improbable that it will ever entirely disappear from India. The subject has received some attention. The introduction of improved furnaces like the Sindewahi, the substitution of three-roller iron mills for the old stone and wooden mills, and the use of better boiling pans, have undoubtedly effected a certain amount of good, but there is much room for further investigation both into the process of manufacture and, in particular, into the question of fuel. A very important side of the activities of any agency set up for the improvement of the Indian sugar cane industry will be connected with the problems of *gur* manufacture.

India as an Exporter of Sugar.

In all discussions on the Indian sugar position it is a common-place to emphasise that at one stage India was a considerable exporter of sugar, whereas latterly, and for a very large number of years, she has been an importer. The early records of the East India Company from 1609 onwards indicate an European enquiry for Indian sugar and various trial consignments are referred to.

When we come to more recent years the following figures of Indian exports of sugar to Great Britain may be of interest :—

In 1800 the British imports from India, expressed as raw sugar, came to 6,023 tons ; in 1821, to 13,861 tons. Some twenty years later Indian exports to Great Britain amounted to 96,875 tons ; in 1851, to 75,307 tons. The next decade marked great shrinkage, as the exports to Great Britain fell to 34,800 tons only. Expansion of the industry in British Colonies under European management and control proved a serious competitor and, in fact, ultimately killed the Indian trade.

It seems unnecessary to give the variations in export of sugar, raw or refined, for any long period of years ; the present position is summarised in the figures for 1924–25, 1925–26, 1926–27.

EXPORTS TO ALL DESTINATIONS.

	1924–25 Tons.	1925–26 Tons.	1926–27 Tons.
Sugar, both raw and refined	1,058	600	627
Jaggery	20,002	1,924	1,487

It will thus be seen that the export trade in sugar has practically vanished. One may, perhaps, be permitted to question the economic soundness of the position when India was an exporting country, for there are indications that even then India, instead of turning its attention to the manufacture of superior qualities of sugar within its own borders, was a considerable importer of the refined article from China and Egypt. The position would appear to have been that the art of refining sugar was not generally known to the people of India. A couple of centuries ago, therefore, India consumed a far larger proportion relatively of crude sugar (*gur*) than it does to-day. The East Indian Company made strenuous efforts to develope internal trade and stop imports in these early days by meeting the demands of Bombay from the surplus stock of Bengal, and, to facilitate this, transit dues on sugar were removed and an import duty placed on foreign supplies. Even with this protection Indian sugar did not assume control of its own markets. Large supplies continued to pour in from Egypt and China. In later years Batavia and the Straits, Mauritius and the West Indies, became formidable producing centres and exporters to India, while another disturbing factor was introduced—the large supplies of cheap beet sugar which appeared in India from Europe. The inevitable result of all this outside competition has been a slow awakening to the fact that India must turn her attention to the improvement of her own refined sugar if she is to compete in this market at all.

INDIA AS AN IMPORTER OF SUGAR.

The figures for export fade into utter insignificance when compared with those of import. These show a progressive increase annually as a decennial review will indicate. In 1871–72 India imported about 28,000 tons of crystallised sugar; ten years later the figure was about 49,000 tons and in 1891–92 over 125,000 tons. At the beginning of this century imports were over 275,000 tons, consisting of equal proportions of beet and cane sugar. In 1926–27 the total imports amounted to no less than 826,900 tons, of which Java contributed 611,700 tons. I understand that the figures are now even higher. The foreign imports of sugar have so firmly established themselves that it seems likely that they will be a permanent feature of the situation. This foreign competition has always caused a certain amount of anxiety in India and the method of combating it has generally been by means of Tariffs.

TARIFFS.

Until the Mutiny the general rate of import duty levied in India was 5%, but owing to the financial stringency consequent upon the Mutiny it was necessary

to increase it to 10%. In 1864 the rate was 7½%, reduced in 1875 to 5% again. In March, 1899, under the Indian Tariff Amendment Act, duty was imposed on bounty-fed sugar from foreign countries. This Act was framed with the intention exclusively of counter-vailing bounties paid directly or indirectly by foreign governments, and gave the Government of India power to impose additional duty on sugar imported into India equal to the net amount of bounty or grant paid or bestowed directly or indirectly by the country, dependency or colony exporting such sugar, however that bounty might be paid or bestowed. But this did not stop the influx of cheap European sugar. The closing of the American markets as a result of the Act of 1897, which imposed counter-vailing duties on bounty-fed sugar, resulted in the diversion of still larger supplies of European sugar to the Indian market. To counter-vail this artificial surplus the Tariff Amendment Act No. VIII of 1902 was passed, the relevant clause of which is :—

> "Where the rate of duty or other taxation imposed in any country, dependency, or colony upon sugar not produced therein exceeds the rate of duty or other taxation imposed on sugar produced therein by more than the equivalent of six francs per one hundred kilogrammes in the case of refined sugar or five francs and fifty centimes per one hundred kilogrammes in the case of other sugar, then the Governor-General in Council may impose, in addition to any other duty or taxation imposed by this Act or by any other Act for the time being in force, a special duty not exceeding one moiety of such excess."

The immediate effect of this legislation was to diminish imports of sugar from Europe and to divert trade principally carried on with India by Germany and Austria, to countries which did not come within the scope of the new legislation. Fresh supplies of cane sugar were thus liberated, which poured into India. Imports of beet sugar in 1902–03 were only about half those of 1901–02, while imports of cane sugar from Mauritius, Java, and China, increased by more than 40%. Eventually, in December, 1903, orders were issued remitting the counter-vailing duties chargeable on sugar produced, after August of that year, in countries which have limited their direct or indirect bounties on sugar and their protective duties, to the minimum permitted by the Brussels Convention of 1902.

Before the outbreak of the Great War sugar was admitted into India free of all legislative restrictions except the ordinary import duty of 5% on all foreign goods, and the counter-vailing duties against sugar produced in or exported from certain countries (Denmark, Chili, Argentine Republic, Russia, etc.), which had not adhered to the Brussels Convention. The import duty was raised to 10% *ad valorem* in 1916, 15% *ad valorem* in 1921 and 25% *ad valorem* in 1922. It was converted into the present specific duty from 1st June, 1925, and amounts to Rs. 4–8–0 per cwt. of sugar 23 D.S. and above, and of Rs. 4–0–0 on sugar from 8 D.S. to 22 D.S. Sugar below 8 D.S. is subject to an *ad valorem* duty of 25%.

In spite of the very substantial amount of protection which these import duties afford there is a tendency in certain quarters to demand still higher protective duties. Personally, I am of opinion that the limit of protection by tariffs has been reached and I do not consider that any further assistance on the lines of a protective tariff would be justifiable. In connection with these import duties it is pertinent, however, to remark that they are avowedly intended for revenue purposes, and they have admirably fulfilled this intention, as they now bring over six crores of rupees annually to the Government of India. I think it may also be admitted that they have afforded a certain measure of protection to the local sugar industry and, had it not been for this duty, Java, which with its highly-organised industry can manufacture sugar at Rs. 5 per maund, would have been able to dominate completely the Indian sugar trade. On the other hand, the Indian import duty has not checked imports to any appreciable extent, and as the price of sugar has come down from over Rs. 30 per maund in 1920 to Rs. 10 per maund now, the protective duty does not much affect the consumer. The protective policy has also, I think, acted to an extent as an encouragement to Indian sugar manufacture and has probably saved the industry from complete extinction. As I have said, however, tariffs have reached their limits, and it is in other directions we must look for any permanent improvement of the position. Let us now consider what has been, and is being, done to improve Indian sugar cane.

WORK BY THE AGRICULTURAL DEPARTMENTS.

Since the Departments of Agriculture were re-organised in 1905, the question of improvement of the Indian sugar industry has received considerable attention. At the meeting of the Board of Agriculture at Cawnpore in February, 1907, exhaustive material was prepared on the lines of a scheme suggested by Dr. Barber, then Government botanist of Madras, for an official enquiry into the Indian sugar cane industry. A report on the position in each province was submitted and examined, and as a result the Board of Agriculture urged local governments to consider the advisability of granting concessions to central factories when suitable tracts for the establishment of such factories could be found, and indicated the lines on which sugar cane experiment stations should be established and conducted. The Government of India left it to local governments to deal with these recommendations, but it is to be feared that very little action was taken on them.

The matter again came before the Board of Agriculture at their meeting in 1911, and a series of resolutions were passed, of which the most important were :—(1) that the sugar cane industry deserved the assistance of the Government ; (2) that the Board accepted the recommendation of the Committee regarding the employment of a sugar engineer ; (3) that the establishment of a sugar station on the north of the Ganges was most desirable in the interests of the industry ; (4) that the Board accepted the recommenda-

tion of the Committee regarding the establishment of an acclimatization and cane-breeding station in Madras. These recommendations were fortified by a resolution of the Imperial Legislative Council on the 9th March, 1911, which advocated a special enquiry with a view to preventing contraction of Indian sugar cultivation owing to the import of foreign sugar. As a result the Government of India took action. A sugar engineer was appointed by them to work under the Government of the United Provinces. A small government factory was erected at Nawabganj, designed to turn out one and a half tons of sugar per day of 24 hours. It was a five roller mill and the equipment differed little from that of the modern factory except for the omission of an intermediate vacuum evaporator. The factory, as far as efficiency of the mill was concerned, was a success, but the experiment failed because the evaporating capacity was not equal to the crushing power, while great difficulty was experienced in securing adequate supplies of cane. The experiment demonstrated that the direct manufacture of white sugar in small factories with open pan boiling is unlikely to succeed on account of the high cost of production, heavy loss of crystalline sugar, and unduly high proportion of molasses.

It was the fourth resolution of the Board of Agriculture in 1911 that was destined to bear greatest fruit. The Government of India accepted the Board's recommendation and in 1912 submitted a proposal to the Secretary of State that an acclimatization and cane-breeding station should be established at Coimbatore in the Madras Presidency, and that Dr. Barber should be placed in charge of it for a period of five years. At first, control of the appointment was left to the Provincial Government on the understanding that the officer appointed would be expected to tour throughout India and use his appointment for the benefit of all Provinces alike, the expenditure being met by the Government of India. Dr. Barber entered on his duties on the 1st October, 1912, and retired in 1919. It is impossible to over-estimate the value of the work which he did for the sugar cane industry of India during his appointment, and it is safe to say that if the work is continued along the lines laid down by him and under competent supervision the thin cane problem of India will be solved. The work has now been made permanent, and been taken over by the Government of India. A second officer is being recruited to do breeding work on thick canes. The Coimbatore station has already more than justified its existence by the evolution of new cross bred canes, some of which, notably Coimbatore 205/210, 213/214, are now grown in extensive areas of the Punjab, United Provinces, Bihar, and Bengal. In the western circle of the United Provinces the area under Coimbatore canes is some 40,000 acres, while in Northern Bihar it is over 12,000 acres. Not only do these canes give a higher yield, but they have the further advantage that they do not demand a standard of cultivation and manuring which it is beyond the power of the cultivators in these parts to give them. The introduction of these Coimbatore seedlings in the sugar tracts of Northern India has completely revolutionised the position so far as the white

sugar industry is concerned, and upon their further spread depends largely the extension of sugar refineries in Northern India.

As regards the thick canes, much valuable work has been done by Mr. George Clarke at Shajahanpur, by successfully introducing exotic varieties and by careful attention to all agricultural processes involved in their cultivation. Very large tracts in the United Provinces are now under these improved selected canes.

It is, however, important to realise that even with reference to the *gur* industry, the value of the improved canes which are being introduced will be very largely diminished if improved methods of crushing and boiling do not go hand in hand with the increased yield. At present Coimbatore canes are being distributed fairly rapidly and widely, but a really efficient mill to deal with them has not yet been discovered. Until the manufacturing side of the country sugar industry is made efficient, the increased cane yields will merely increase the waste and the benefit to the cane grower will be largely lost.

The improvement of the faulty methods of dealing with the cane will first be reflected in the improvement of the *gur* and *rab* industry. But to check import of foreign sugar, the establishment of modern efficient factories is the only solution. India at present is not making the fullest use of her raw material; the waste that is going on is simply colossal. The acreage under cane last year was 3,071,000 acres and if we deduct 16 p.c. as providing cane for chewing, setts for planting, and for cattle fodder, we are left with 2,580,000 acres. Out of this, roughly, only 80,000 acres provide cane for the manufacture of sugar in modern factories. The produce of the remaining area is converted into *gur* or raw sugar.

As Mr. Noel Deerr has pointed out, by following the present cane crushing and *gur* boiling processes, India makes 2,500,000 tons *gur* (10 tons cane per acre as average yield and 10 maunds of *gur* as the average outturn from 100 maunds cane). This *gur* at the average value of Rs. 5/per maund, or Rs. 140 per ton, fetches Rs. 35,00,00,000. If the produce of these 2½ million acres is converted into sugar in an efficient modern factory (recovery 9 p.c. on the weight of cane), 2,250,000 tons sugar and 820,000 tons molasses will be turned out. Taking the selling price of sugar at Rs. 300 per ton, we get a value of Rs. 67,50,00,000 and molasses at Rs. 1/per maund or Rs. 28 per ton, will be worth Rs. 2,20,60,000=Rs. 69,79,60,000, or Rs. 34.8 crores more than can be realised from *gur*. No other country in the world could stand such colossal waste of available material. The responsibility which rests on all concerned for putting an end to this state of things is great. There are at present only 40 sugar factories and refineries and their combined output is hardly 100,000 tons per annum, while India imports over 800,000 tons a year. It will thus be clear that there is ample scope for many more factories and they will not have to look for outside markets, as the demand for the sugar turned out in Indian factories is at their very doors.

The late War is responsible for an awakening interest in the development of the sugar industry. Sir Claude Hill, in his opening speech at the tenth meeting of the Board of Agriculture, which was held at Poona in December, 1917, stated that the War had brought to a head the desirability of dealing with the sugar cane question in India on a more thorough and scientific footing and that it had also served to show the opportunity afforded in the matter of sugar of bringing about a situation in which India may become not only self-contained in the matter of its production but may even become an exporting country. It was felt that as a preliminary it would be desirable to bring together and co-ordinate the scattered work on the subject that had been, or was being, done in the different Provinces and that this could best be effected by a Bureau of Information, where all work done could be reviewed and the masses of information already available in the country sifted and collated. Accordingly, proposals for the formation of a Bureau were submitted by me in July, 1918. The full scheme provided for a factory expert, an engineer, a chemist, an agriculturist and botanist, with an officer as Secretary of the Bureau. I suggested, however, that it would be sufficient to develop the scheme in two stages, the first stage involving only the appointment of a Secretary to the Bureau and a sugar Technologist. This stage of the proposals was accepted by the Government of India, who sanctioned the formation of a Bureau with Mr. Wynne Sayer as Secretary, but the question of the appointment of a Technologist was held over for further consideration. Unfortunately, elaboration of the scheme has gone no further than this and the only appointment that has been made is that of Secretary to the Sugar Bureau. The Bureau has been in existence for the last nine years, and I give the following appreciation of it by Dr. Barber as recorded in his evidence before the Royal Commission on Indian Agriculture :—

"I have followed the reports of the Secretary on the Sugar Bureau year by year, with great interest, and I would like to record my thorough appreciation of the work that Mr. Sayer has been able, single-handed, to carve out for himself, although new to the subject. Two of his lines appear to me to be of special importance :—

"1. The accumulation of a mass of information on the trade side, for the benefit of those engaged in the sugar industry.

"2. His most successful propaganda work on the Coimbatore seedlings in Bihar."

In 1919, the Committee of the Indian Sugar Producers Association at Cawnpore represented that the time had arrived for some steps to be taken for the improvement and development of the sugar industry in India and for the announcement by the Government of India of the policy it proposed to adopt, particularly in its fiscal aspect. As a result of this representation, combined with the general awakening of interest in the subject, an Indian Sugar Committee was appointed to go thoroughly into the whole question. It is a matter of great regret that the major recommendations of that Committee have not been given effect to. Among these recommendations were :—

1. The creation of a Sugar Board.
2. The creation of a Sugar Research Institute with a net-work of sub-stations in all important sugar tracts throughout India.
3. A pioneer model sugar factory.
4. A Sugar School.

At present, the Indian sugar industry suffers from two main disabilities, the first agricultural and the second concerned with the manufacture of cane into raw sugar. The first is the extremely low yield of sugar cane per acre over large tracts of India. Improvements in yield can be brought about by wider extension of Coimbatore cane ; this has been abundantly proved by the success achieved in Northern Bihar and part of the United Provinces. There is also great room for improvement in the standard of cultivation, manuring, etc.

It was the idea of the Indian Sugar Committee that research and propaganda in connection with sugar cane should be largely centralised under the Sugar Bureau or Indian Sugar Board which it was proposed to establish. The position has been considerably affected by the Reforms and the transfer of agriculture to ministerial control, but it seems to me that even with this administrative change there is considerable work to be done by the Central Government in the matter of the development of the sugar industry. The question is an all-Indian one, and it does not appear to me to be altogether impossible to develop a system in which the majority of the recommendations of the Indian Sugar Committee could be carried out by the Central Government, while local governments would assist in giving effect to the recommendations of this central research body. In most Provinces financial considerations and proper balance between the claims of sugar and other agricultural crops might make it impossible for particular Provinces to devote the time or money necessary for research into problems connected with sugar, although they might have staff and finance adequate to give effect to the recommendations emanating from the Government of India Central Sugar Research Bureau.

I venture to think that sugar is one of the matters for research which should receive attention from the Central Government, and that the general policy, both of research by the Government of India and of local research and propaganda in the Provinces, is one to be taken up by the Council of Agricultural Research, which has been recommended by the Royal Commission on Indian Agriculture. No doubt this Council in framing its policy will take into consideration the various recommendations of the Indian Sugar Committee and see how far these proposals can be fitted in with existing conditions.

If the Indian sugar industry is to be saved, the problems must be tackled at once and assistance must be given to Provinces where the crop is of importance, so that they can delegate officers to devote their whole time to work on sugar. There is no need to increase the present area under cane, or to infringe on areas at present utilised for other food crops. Already the area is nearly double what it need be if the sugar cane industry were efficient. If Java, with

450,000 acres, can turn out 2,300,000 tons of sugar per year, it is surely not too much to hope that India, with its three million acres, will be able to produce at least enough to meet her internal needs. I do not minimise the advantages which Java possesses as compared with India. The Java system permits of factory control of concentrated areas, and this undoubtedly makes her problem easier, but, apart from this, the outstanding position of Java in the sugar world has been built up almost entirely on the application of extensive scientific research to the problems of the industry.

In India it is not in most cases possible to obtain factory control of land and cane will frequently have to be collected from small and scattered holdings. At present most of that sugar cane is inferior, but if, as a result of research, better cane is available, we need have no fear of unwillingness on the part of the cultivator to take it up. Nor is it a matter of any great difficulty for a factory to work up a connection with local cultivators to ensure regular supplies. Scientific research and factory organisation are the key-notes to the solution of the problem.

Suggestions.

In conclusion, I may perhaps be permitted to indicate very generally the lines upon which I consider the problem should be tackled.

I repeat that in my opinion the limit of tariff protection has been reached. We must attack the problem from the agricultural and manufacturing side. My suggestions are :—

(1) That the work of the cane-breeding station at Coimbatore should be continued and extended and that arrangements should be made to ensure continuity. Dr. Barber has gone and Rao Bahadur Venkataraman cannot go on for ever. A thoroughly competent botanist should be in training to carry on the work when a vacancy occurs. I say *thoroughly competent.* The only consideration that should influence an appointment to the staff of this station is that the very best man available should be secured.

(2) In Provinces in which sugar cane is of importance one deputy director of agriculture should be recognised as the provincial sugar cane expert and so far as possible his labours should be limited to the one crop. It will be his duty (*a*) to study the local canes and select the best of them ; (*b*) to make such arrangements as may be necessary for the careful testing of his own selected canes and of the Coimbatore canes and for the multiplication and distribution of such improved canes as may be recommended.

(3) While work in the Provinces must naturally be entirely under Provincial control, arrangements should be made for the closest collaboration between the Imperial sugar expert and Provincial officers working on sugar cane. The Central Board of Agricultural Research should be in a position to arrange the necessary links between Imperial and Provincial officers. It is of vital importance that there should be the closest relations between Coimbatore and

Provincial officers and exchange of visits between them should be encouraged. No obstacles should be placed in the way of the Imperial sugar cane expert and he should be encouraged to travel freely over India in order to keep in touch with the developments in the Provinces and to observe the behaviour of his selected seedlings under the varying conditions which will be found up and down India. I emphasise that to ensure success of the Coimbatore work and to guarantee its spreading all over tracts of India where Coimbatore canes are found to succeed there must be the closest collaboration between the sugar cane expert and Provincial workers. All petty jealousies must be sunk and all must work with a common aim.

(4) Where composite blocks of suitable land are available and where there are no local difficulties, large grants of waste land suitable for the cultivation of sugar cane should be given to groups or individuals who are prepared to erect a modern sugar factory. We cannot get away from the fact that the great factor in Java's success is that factories have control of the land and are both growers of the cane and manufacturers of sugar. Where, therefore, a similar position can be developed in India without interfering with the general interest of the community, the Government should have no hesitation in granting land on favourable terms to manufacturers who are prepared both to grow and manufacture sugar.

(5) It will be for the Council of Agricultural Research to decide whether a central Sugar Research Institute is required and whether the Government should set up an experimental sugar factory. Personally, I do not think that the latter is necessary, but the former might be the best and cheapest way of working out problems of general application connected with crushing, small power installations, fuel consumption, and the like, and also the innumerable problems connected with *gur* manufacture. Indian scientific workers could also be trained there.

(6) It will also be for the Council of Agricultural Research to decide whether the Sugar Bureau should be made permanent, and, if so, on what lines it should continue to work.

(7) Agricultural problems connected with sugar cane must be worked out locally in the Provinces, but a mycologist should be attached to the Coimbatore station, whose personal concern would be investigation of the diseases of sugar cane and whose services would be at the disposal of all Provinces. The Java industry was saved from complete ruin in 1884 by concerted scientific attack on the *Sereh* disease, which threatened to exterminate it. A similar calamity may strike India at any moment, and we must be prepared to meet such a possibility.

All over the world areas under sugar cane are increasing. Agricultural and factory efficiency are advancing in practically every country, and each year sees conditions for an inefficient industry made more and more impossible.

It is no exaggeration to say that no duty of any reasonable size could have kept the Indian sugar industry as it existed before the War alive at the present day. Its own inefficiency must have strangled it. In recent years there has been a stimulation of interest and efficient factories are springing up. Efforts should not be relaxed, and if there is a fixed determination to tackle the problem seriously there is no reason to despair of the future of the industry.

DISCUSSION.

Dr. C. A. Barber, C.I.E., Sc.D., Lecturer in Tropical Agriculture, Cambridge University, said he greatly appreciated having been invited to hear Sir James MacKenna's very able paper. He said "able" for two reasons, first of all because it was by MacKenna, and secondly, because Sir James had had unique opportunities of getting hold of the details of sugar industry in India on the higher plane, taking a large view. Personally he had for a long period been engaged in the humbler duties of trying to get to know all about the cane, trying to grow it, and trying to improve its yield of sugar. One of the subjects which had interested him greatly had been the origin of the sugar cane, and he would like to say one or two words on that point. When he had first started studying the sugar cane intensively, he had thought, as most others had done, that it was probably derived from the wild cane of which the lecturer had spoken, called *S. Spontaneum*; but the problem had got more and more difficult, until finally he had had to give it up. The present general view was that the cultivated sugar cane had to be divided into two entirely separate classes of different origins. That was a recent view which was now generally accepted by students. He gave that as an addendum to the view which the lecturer had expressed, and which had been held at the time of the Sugar Committee. In the first place the North Indian canes were very different from the tropical ones. The North Indian canes were thin and hardy, had much fibre and little juice, although the sugar was sometimes very good. It was assumed generally now that these had arisen in India itself around the northern shores of the Bay of Bengal. It was almost impossible to conceive of the tropical sugar cane having arisen in India. Those who had tried to grow it there (except in the extreme south, and nobody claimed that it arose there), could definitely say that it was not likely that it would have occurred there first; and the general view now was that the tropical cane had arisen from an entirely separate form in the islands of Oceania, and especially New Guinea. He had always thought that New Guinea was the place to look for the origin of the thick canes, for the reason that a number of years ago the Australians in Queensland had sent over men to explore the country for sugar canes, and they had taken back an extraordinary number of different kinds, some of them better than the sugar canes which were then already growing. Anybody who knew the interior of New Guinea could quite see that there were no possible means of influence reaching it from India. With that view he concurred fully, and he might say that the United States had recently placed a large sum of money at the disposal of one of its bureaux—that of plant industry—in order to try and improve the sugar industry. An expedition had been to New Guinea and had just returned with a large consignment of those original canes. An interesting point about New Guinea was that every village had its own particular kind of cane; one had a red one, another a yellow, another a striped, and another had one with different bands of colour, which seemed to him to argue a very ancient tradition.

He need not say any more on that subject; it was a large one, but he thought he would bring the question of origin up to date so far as it had gone. It, of course, might be quite wrong, but that was the present view.

Recently he had been studying the factors involved in costs of producing sugar in some of the different countries of the world, with rather extraordinary results. Queensland was stated to take £25 to make a ton of sugar, in spite of lovely canes, including some of the New Guinea ones, and an excellent climate. The labour was very dear—17/- a day—because of the ideal of a White Australia. Cuba produced its sugar at from £6 to £7 per ton, but the labour cost was high—5/- a day. Java produced its cane at about £7 to £8 a ton. It had the cheapest labour in the world—10d. a day—except that of India, which was 4d. to 8d. a day; yet it cost India £11 to £15 per ton to make sugar. Labour, then, was not the only key to the situation. There were many other factors. One of them was that the factories in India were extremely small, though the actual manipulation in the factory had greatly improved in recent years. The factor, however, with which he personally was most concerned was connected with cane breeding, and its very great importance was illustrated by certain startling figures which he had come across lately. These applied to Java, which was the country in closest competition with the Indian white sugar industry. In 1912-13, with about 450,000 acres of land, they had produced about 1,300,000 tons of sugar. At that time it had been considered that there was no chance of much expansion in Java, because almost all the land fit for sugar cane and which could be released by Government for sugar cane growing, was already used for that purpose. There were two periods since then to which he would like to draw attention. In 1919-20 the figure had been 1,500,000 tons, and in 1923-24 it had been 1,700,000—much to the surprise of people outside Java. The second period was much more interesting. In 1926-27 the figure had been 2,300,000, and in 1927-28 it had been 2,900,000. The estimate for next year was 3,200,000. What was the factor? The factor was obviously connected with new kinds of cane. Java was the Mecca of cane breeding, and was raising new seedlings of better characters. A number of those improved seedlings had been developed in the first period of 1912-24. There had been also improvements in technique in the mills, in the manuring and in every portion of agriculture, but nothing to account for the increase in quantity produced per acre. In the second period, from 1926 to the present day, a strange new seedling had appeared under the name of "P.O.J. 2878." Hitherto they had specialised in Java, as they had tried to do in India, in finding cane seedlings particularly suited to different kinds of soil in different parts of the country. They had succeeded admirably, so that every estate knew just what kind of seedling was to be planted in each part of the estate. Now they had come across a cane which could grow anywhere, and the result of that was that all the former kinds were being scrapped. The new seedling was displacing the others, and it was calculated that in the next year—the present year in fact—it would fill the whole of Java. That, he took it, was a very strong argument in favour of pushing cane breeding to its extreme limits, as long as it was properly done.

Reference had been made by the lecturer to the number of acres devoted to growing the new canes at Coimbatore. He would like to give further figures indicating the spread which was now becoming rapid. Those canes had been released for trial in North India in 1918-19, and the period of trial had been reckoned to be from 3 to 5 years before it could be said that the canes were suited to North India. They had been evolved over a thousand miles south in tropical India, for the reason that the seedlings could not be got in North India because the canes did not

flower there. He had not been able to keep in touch with the increased areas very accurately, but casual friends had sent him statements from time to time. There was one definite statement, however, which he had got in print from Mr. Venkataraman. In 1926 Mr. Venkataraman stated that 24,000 acres were under the new canes, and that this area gave £100,000 profit to the cultivators. In 1927, which was about the period with which the lecturer dealt, there were 60,000 acres under those canes, and within the last few days he had received information that the acreage this year would be 150,000. Therefore there was an improvement, and he was glad to hear of it.

He desired, in conclusion, to express his great appreciation to the lecturer for the extremely kind manner in which he had referred to the work which he, personally, had been able to do.

Mr. George Pilcher, M.P., said he was not an expert in the subject. His only qualification to be interested in it at all was that he had owned a few shares in one of the mills which had been established at the time of the renaissance about 1919-20. As one who took an interest in India's economics generally, he might make the rather obvious remark that sugar production did seem to offer a very great opportunity in the future if some of the recommendations of the Agricultural Commission were carried into effect. It seemed obvious that the Central Agricultural Council, if and when it was established, should turn to that great opportunity and make some effort to develop India's sugar possibilities. It seemed tragic that Java should come second in the rank of countries importing commodities into India mainly on account of her enormous sugar production, and that India should utilise her own sugar acreage to such relatively small advantage.

Sir Henry Staveley Lawrence, K.C.S.I., remarked that the lecturer appeared to hold that the Government had done all they could to encourage sugar cane cultivation in India. That was a debatable point. The cultivation of sugar in every country in the world had been fostered by Government, and he doubted whether it had made its way in any country in the world without having been definitely fostered by Government. The lecturer would confine assistance by the Government of India to the agricultural and engineering side, but he had not given any reasons why he considered that it should not be extended to providing a sufficient tariff to give adequate protection to the industry. The tariff which had been imposed was much lighter than had been imposed in England to help the beet sugar industry. It was much lighter than that imposed in South Africa, where they had an effective protection against Java competition. The fact was that the Government of India had throughout maintained that their tariff was purely for revenue purposes, and had refused to admit that it was a tariff for protection. Figures had been given which showed that the importations had increased four-fold of recent years. He was told that the importations, almost entirely from Java, had doubled within the last year. It was an open question whether that was for the benefit of the sugar cane cultivator in India. It had been stated that the area under cultivation in India was 3,000,000 acres. Assuming that one acre supported a man with a family, that meant that there were 3,000,000 families dependent on the industry in India, which showed that it was a matter which should receive a great deal more attention from the Government than it had yet received. The mere fact that for over ten years very little had been done to carry out the recommendations of the Sugar Committee was sufficient to indicate that the economic considerations in India had not received their proper share of attention. The recent Royal

Commission had given their support to the recommendations previously made by Sir James MacKenna's Committee, and if any words from the Royal Society of Arts could help to stir the memories of the members of the Government of India, he hoped they would be forwarded and have that effect.

MR. H. A. F. LINDSAY, C.I.E., C.B.E., Government of India Trade Commissioner, said he had been a witness before the Sugar Committee when Sir James had been in the Chair, and he remembered the trying ordeal that he had gone through when Sir James had extracted every ounce of information out of him with the same efficiency as the most up-to-date sugar crushing machine. The point at which he himself had come into contact with the sugar industry lately was chiefly the commercial side. There was a tremendous fight going on at present between the cane sugar industry and the beet sugar industry. There was one interesting point in connection with that competition, namely, that the beet sugar industry was an agricultural crop, and therefore in the ordinary course if prices went against the grower he could shift on to some other crop ; he had usually some reserve to fall back upon, but in the sugar plantation industry one could not shift on to any other crop ; the land was laid out under sugar, the factories were laid out for sugar, and there was an enormous amount of capital locked up in the concern. In India the cultivation of cane-sugar was an agricultural and not a plantation industry. One difficulty in regard to India was that many of the factories were in close competition with each other. That might sound as if prices should be brought down in consequence, but that was not really the result, because where too many factories were found in a small area those factories had to compete with each other for their raw material, and therefore the tendency was for prices of the raw material to rise. Exactly the same situation was going on in the cotton ginneries in Kenya Colony. He thought the lecturer would probably find that Indian sugar factories had to pay high prices for the cane in the immediate neighbourhood of each factory ; hence the high prices of the refined sugar which they turned out.

MR. J. C. SINHA said the lecturer had stated that the limit of tariff protection in the case of Indian sugar had been reached. Personally, he would like to express the opinion that the sugar tariff had not had a fair trial in India. The present 25% duty was a revenue duty, and, as such, there was no certainty that it would be continued for some time to come. It was, therefore, evident that Indian capitalists would hesitate to embark their capital in the industry. If the Indian Government had definitely said that the duty would be continued for a series of years, a different state of things might have resulted.

A protective tariff was not the only method for resuscitating the Indian sugar industry, but he refused to believe that it was not one of the methods. By means of tariffs the sugar industry in other countries had been stimulated. The lecturer had stated that the art of refining sugar in India was more or less a recent one, but as a student of history, he had read that very fine sugar had been produced at Bianah near Agra in the 16th century, and there was reference to the production of fine sugar at Ahmedabad in the 17th century. With regard to the competition between Java and India, it was interesting to note that one of the earliest references to the competition of Java sugar was to be found in a letter written to the Court of Directors of the East India Company in February, 1758.

MR. F. H. SKRINE, I.C.S. (retd.), said that although the lecturer had put forward several recommendations for the future improvement of the sugar industry in India,

there were two further ways in which the Government could assist, and which were not mentioned in the paper. One was co-operation. He had just returned from Ireland, and he had been surprised to find how, throughout the whole of the Irish Free State, co-operation had changed the position of the agricultural industry there. The second was by improving and standardising the production of the cane. It was extraordinary to see the present differences there were in the canes, and it seemed to him that the Government could render enormous assistance to the sugar industry in India if it established experimental farms for the raising of the best kind of cane, and distributing it freely to cultivators.

Sir James MacKenna, in reply, said that, as was so frequently the case, the discussion had been of very much more value than the paper. As the audience would have realised from the points that had been raised, the subject was one of enormous compass, and could be viewed from all sorts of angles. Bearing that in mind, he had decided that the best way to set the ball rolling was to be as general as possible; and that had had the desired effect. Sir Henry Lawrence was a determined Protectionist, and his views had been shared by other members of the audience. His own economic views happened to differ, and he would leave it at that. He would only ask those who held the view that the limit of tariff had not been reached, what tariff rate they would propose to suggest which would keep out Java's efficiency? The success of Java had been entirely built up on its efficiency. Notwithstanding that India's tariff barrier had been raised again and again against Java's sugar, steadily and annually Java's imports of sugar increased. Mr. Sinha's economic history was first rate. It confirmed everything which he himself had discovered in the process of writing the paper. With reference to Mr. Skrine's remarks, no one had been in closer touch with co-operation in India than he had himself. He was afraid, however, that in regard to economic and agricultural ills, co-operation was something like the blessed word "Mesopotamia." "Mesopotamia" had had the good fortune to have had its name changed to Iraq, and one wanted to introduce a new name for co-operation. Co-operation was the broad back on which everyone put their troubles. After two years of close study of the situation in India, his colleagues on the Royal Agricultural Commission sincerely hoped that co-operation would be able to shoulder the burdens which everyone was inclined to, and intended to, place upon it.

A hearty vote of thanks to the lecturer concluded the meeting.

Mr. W. H. Moreland, C.S.I., C.I.E., writes:—

I regret that I was unable to attend the recent meeting of the Society's Indian Section, or take advantage of Sir James Mackenna's suggestion that I should contribute to the discussion an account of some of the earlier stages in the efforts to modernise the Indian sugar industry. The Secretary of the Section has now asked me for a note on the subject, and I am glad to comply with his request, though I can tell only of ancient history—ancient as India now measures time.

What struck me most in reading a proof of Sir James Mackenna's paper was that it is now possible to talk of the industry without referring to religion: thirty years ago, religion either dominated or underlay the discussions on the subject. At that time it was almost universally believed that all white sugar made in factories, whether in India or elsewhere, had been in contact with animal charcoal or other products of the sacred cow, and consequently was a pollution to Hindus. The belief was not fully justified by the facts of the industry, but it existed; and

to contradict such beliefs directly is merely a waste of time. When, therefore, the flood of foreign sugar reached Northern India, the cries of the local industry were reinforced by a sentiment so strong that no Government would have been justified in disregarding it.

Preliminary investigations showed that the foreign sugar did not immediately threaten the producers of *gur* for comsumption, who had in their favour social habits of the type which changes most slowly. It was recognised that *gur* would eventually be affected, and some figures given by the lecturer suggest that this change is now in progress; but the social protection, so to speak, justified the view that the change would come slowly, allowing ample time for gradual adjustment.

The case was different with the important white sugar industry of Rohilkhand, which was threatened directly by the foreign supplies. This industry had one merit, in that it produced marketable white sugar to which no religious objection existed. In every other respect it was a thoroughly uneconomic proposition, based on inferior cane, wasteful of raw material, extravagant in labour at a time when wages were rising, and so tedious as to involve heavy interest charges. The foreign sugar was so much cheaper that in a free market it must have killed the local industry at once: the religious protection which the latter enjoyed gave it a breathing-space, but, unlike social protection, could not be relied on for long; and the question was whether that breathing-space could be utilised to put matters on a better footing.

This question had to be attacked simultaneously on two lines, the raw material, and the processes of manufacture. On the first line, a study of the indigenous canes were undertaken, directed to ascertain whether, by suitable treatment, they could be made to serve as the basis of an efficient industry. This study gave valuable, if negative, results. It proved that the indigenous canes were not good enough; and it led to the movement for establishing a cane-breeding station, which, as the lecturer has recorded, came into existence in the next decade.

As regards processes, the idea of establishing modern factories had at first to be ruled out. Sufficient capital could, perhaps, have been raised, but a quarter of a century ago neither business enterprise nor technical skill was available; while the religious objection to any sort of factory-made sugar was by itself decisive. An attempt was therefore made to improve the indigenous processes, so that, if possible, they might be placed in a position to compete with foreign sugar on less unequal terms. A model plant was worked out on these lines, and shown at work for some seasons. The essential features were the introduction of a centrifugal extractor to separate the molasses, and alterations in the boiling-pans, designed to reduce labour costs.

This process, which came to be known as the Hadi process, was a success and a failure. It was a success in that, given a degree of skill equal to that existing in the indigenous industry, it could turn out a marketable white sugar at a substantially lower cost than the indigenous methods. It was a failure in that eventually it did not commend itself to the men engaged in the industry; and it did not establish itself in Robilkhand, though various modifications of it are working in other parts of India. Indirectly—and this was its real value—it combined with other sources of enlightment to disintegrate the old popular view that any sort of factory machinery must necessarily produce a sugar offensive to religion.

This change in popular opinion in the North was the most remarkable feature of the opening decade of the century. It is scarcely too much to say that, about

the year 1900, a sugar factory was commonly regarded by those who had never seen one, as a place of horror, where, behind high walls, unspeakable orgies were celebrated with the blood and bones of the sacred cow. In 1910, it was found safe to exhibit at Allahabad a modern factory, unwalled, and with ample passages by which anyone who chose had access to every part of the machinery. Mixing with the stream of spectators which flowed for three months through that factory, from the mill where the cane was crushed, past the vacuum pan, to the centrifugals where the white sugar emerged, it was possible to say that the greatest obstacle to an efficient sugar industry in North India had disintegrated, and that the road was clear for men with the skill and enterprise needed to put the industry on a sound technical and commercial basis.

EXHIBITIONS OF APPLIED ART.

Arts and Crafts Exhibition Society. Burlington House.—The Arts and Crafts Exhibition Society has a membership of nearly two hundred. Its importance, potentially, is great ; but one may safely say that it deserves all publicity on account of merits that have already appeared, not merely on the strength of hypothetical benefits that it is likely to confer on British industry in the future. The world, not least Britain and America, suffers from what Professor Saintsbury calls chthesophobia : fear of yesterday : as if traditional forms were like so many old-fashioned uncles and aunts. Inspired by those lovers of the past, William Morris and Walter Crane, the Society is not likely to show signs of a passion for senseless innovations ; it does not do so at present, and one therefore has the pleasure of observing developments of proven styles, and is not faced by examples of cold craft, comparable to and worthy of an ectogenetically produced humanity.

At the same time it is quite clear that a diversity of visions are included within the pale of the Society, which is as it should be, and that we have not here simply an aggregation of skilled connoisseurs. Take the bookbinding section, one of the strongest at the exhibition. Two of the most beautiful books represent opposite poles of design. The one, " Daphnis and Chloe," bound in blue morocco by Elizabeth Pye, is essentially of the twentieth century ; the other, a Communion Book, bound by F. G. Garrett in orange morocco with a design in gold, has qualities of simplicity and good proportion which might have been the product of, and have done honour to centuries past. Other admirable books are W. Moss' " Defence of Guenevere." B. H. Newdigate's " Omar Khayyam," and its smaller neighbour, W. T. Matthews' " Picture Book of Bookbindings." There is also fine printing to be seen, and among the outstanding book illustrations are some designs by Robert Gibbings, whose wood engraving is to-day justly celebrated.

The furniture shown is less good throughout than the book production, but a chest-of-drawers by Russell Workshops is almost very good and a wardrobe in walnut by Edward Barnsley has agreeable features. A group of horses carved in wych elm by W. G. Simmonds fails to convince one that here is wood suitably treated. As in the case of some of the illuminations exhibited, the special talent of the medieval craftsman is lacking ; wooden figures without austerity are childrens' toys, and illuminations without that same quality are apt to be saccharine.

Though none of the pottery is inspired, some pieces are attractive. Kathleen Vowles has a Majolica pot decorated with pleasant colours, of which one, her green, is so good that it is a pity so many others are allowed to jostle it.

Like the books, the printed stuffs are mostly good. Here the influence of Morris is not seen ; instead of patterns in his manner the artists have adopted designs of an

abstract, very civil, modest and modern kind with which it would be easy and pleasant to live. Enid Marx is an able designer ; her printed linen, No. 342, might be taken as a good example of a good collection.

With his lead water heads S. D. A. Saunders has made a fine job of a comparatively small decorative possibility. Old drain pipes are sometimes an adornment to a house with which they are coeval ; modern ones generally are quite ugly without gaining in efficiency.

The silver workers of the Society, among whom are such skilled craftsmen as Paul Cooper, show an interesting assortment of wares. Mabel Camwell's tea-pot is a success.

The architectural room has many drawings by the late Halsey Ricardo, whose use of coloured tiles, as on a large house in Addison Road, found a certain number to applaud. But neither this expedient nor the design of the house in question commend themselves to the present reviewer. The surface of a building is none the worse for a little weathering. The psychological reaction from tiles is like that from too much window space ; they suggest infirmity in the structure and probably, in the long run, end by displeasing those whose imaginations they have at first stirred pleasantly. The less experimental designs of the late Ernest Barnsley are sounder, and based on a good tradition, that of the manors and cottages of the Cotswolds. Mr. Barnsley was also a designer of furniture, and a good example of his craft is on view.

It is impossible in a small space to draw attention to all the notable objects assembled at Burlington House for this exhibition. It must suffice to say that one cannot believe so much talent will not find means and ways of bringing an increasing influence for good to bear on British industry.

Brook Street Art Gallery. Exhibition of Hand-Painted Pottery by Alfred and Louise Powell.—It is now many years since the firm of Josiah Wedgwood gave Mr. and Mrs. Powell the opportunity of co-operating with them in the production of hand-painted pottery. For Mr. and Mrs. Powell are not actually potters, though in certain cases the pots which they paint are thrown after designs submitted by them. In the majority of cases they choose pots made in the ordinary course of business which strike them as suitable for painting, and they return these to Wedgwood's for firing when they have worked on them. They are assisted in their studio by a score or so of girls ; the present exhibits, however, being their own work.

This arrangement is clearly excellent ; it is generally felt that in British industry a closer contact between factory and studio would be desirable, and here is an example of such co-operation which has been a *fait accompli* for hard on a quarter of a century.

As to the exhibits—they are various, both in form and quality. There are huge vases and plates, and smaller, utilitarian pieces ; dishes, jam-jars, coffee-sets and so forth. On some there are patterns, pure and simple ; on others patterns together with formal figures ; on others again we find houses, landscapes or animals. It looks as if the minds and imaginations behind this very sound work were abandoned to a rather pessimistic eclecticism : so many things are tried—and indeed brought to a satisfactory enough conclusion. An effort has been made to cater for a variety of clients with diverse tastes. Certainly, whoever has the taste to buy the charming jam-jar with its mauve Morris-like pattern of boughs and birds will not appreciate to an equal degree the heraldic plate which looks down from a neighbouring wall.

On the whole where Mr. and Mrs. Powell have confined themselves to patterns on conventional lines they are more successful than where they have given reign to their

inventiveness—influenced as they no doubt must be by a public taste that does not maintain a fair average. Their realistic landscapes and fanciful picturesque vistas, their angular hinds and modernist figures, though very clever are not entirely satisfactory. Painting *ipso facto* seems to destroy the intrinsic charm of the wellknown Wedgwood surfaces.

But there is a world of difference between the better work here displayed, which shows both taste and skill, and the tiresome painted pottery that is being produced by less experienced craftworkers in many parts of the country to-day.

COLNAGHI'S GALLERY. Exhibition of Work of Present Day Potters.—Colnaghi's exhibition embraces a wide range of work. Some of it is of that luxuriant, sentimental kind that finds favour in a certain class of prosperous drawing room, where it readily evokes the luscious emotions sought by the more indigent at spectacular films.

Take the groups called "Leda" and "Pharoah's Daughter," by G. Nicholson Babb. The fluency, the pseudo-artistry of such pieces is all too striking; yet they are æsthetically meaningless; conceived in an Albert Memorial spirit. Their sophistication is a pretence; they are skilled craftwork thrown away.

No less clever, no less attitudinising, and even more expensive are the figures by G. Parnell: as, for instance, "The Little Lone Shepherdess," fifty guineas; "Ripe Speragas," thirty-two guineas. There is a streak of devitalised romanticism in some people which enables them to take pleasure in work of the kind.

S. Fox-Strangways shows nine sets of tiles. She is straining in the right direction; her colours are good, her designs are almost good. Perhaps she is a little between two stools, uncertain as to how she should compromise between natural forms and more abstract patterns.

Pleasant shapes and surfaces are achieved by D. K. N. Braden and K. Pleydell-Bouverie. There is a homeliness about their work which is unaffected and agreeable. Mr. Bernard Leach tends to have good shapes and unalluring surfaces, while it is the other way about with L. and W. Norton, who have hit upon a number of surprising bulges with no discernible significance.

P. Simpson is another mistress of the opifact—the work of luxurious ostentation. One is inclined to ask whether her talent would not find more satisfactory expression in silver work. Her ingenuity, indeed her *finesse*, is thwarted by a medium which tends of itself to emphasise extremes. An earthenware jar is ponderous; a Meissen shepherdess too delicate to live. Part of an artist's inspiration consists in measuring the extent to which an admixture of his human individuality should be allowed to bring out the natural characteristics of his medium. If virtuosity in the man is a doubtful good quality, virtuosity in the material is directly unpleasant. There can be no self-determination in the inanimate world.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

THURSDAY, DECEMBER 27..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—Waves." (Lecture I.)

SATURDAY, DECEMBER 29..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—Signalling in Air and Water." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. A few tickets are still available and Fellows who desire tickets are requested to apply to the Secretary at once. Tea will be served in the library after each lecture.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, NOVEMBER 27TH, 1928.

SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair.

THE CHAIRMAN, in introducing the reader of the paper, said that most of those present whose work had been dependent on previously made topographical maps had acquired by superficial observation the impression that the professional surveyor was a man of very conservative habits. To find, therefore, a distinguished member of one of the two or three most distinguished Surveys of the world ready

to take up a system which was so radically different from established and orthodox methods of survey showed, at any rate, in the first place, that they might be quite wrong in regarding surveyors as conservative, and, in the second place, which was much more important, that there must be something fundamentally valuable in the new method of attack from the air. The surveyor was forced to adopt methods that appeared superficially to be conservative. His work was necessarily systematic, being preceded by the determination of base lines with a precision that few map users ever understood. A series of elaborate, expensive, and time-consuming operations were consequently necessary before the surveyor could ever show the patient map reader any visible results for his work. To undertake a survey by photograph seemed also at first sight a radical departure from standard methods, and then to use a rapidly-moving aeroplane as a camera carrier added to their prejudices and other grounds for scepticism in regard to the reliability of such methods for precision of measurement. Nevertheless, developments which had occurred during the past few years, almost entirely since the war and as the result largely of methods forced on us during the war, had changed the camera from an instrument which was used merely to give a superficial impression to one which could be relied on for quantitative measurements. Most of the audience would therefore listen to the paper about to be read with critical interest. Col. Crosthwait's account of that new method would be, to those who had been brought up in the old school, something of an awakening, and he had no doubt at the end of the lecture they would be convinced that the camera could be made to do serious work, recording far more about the contents of a country than its mere topographic outlines. To an empire like the British Empire, including larger areas than any other empire of lands which were covered by an almost impenetrable jungle, the adoption of survey instruments that could be carried freely in the air became of especial value. It removed one of the most serious obstacles which had hitherto delayed the development of many of the natural resources of the Dominions and Colonies. That old Society, in whose lecture hall they were, had been, for some reason which it was unnecessary to investigate at the moment, inspired always with the spirit of the pioneer. It had had the luck or the genius to discover early in their development new methods of work, and at some future date he had not the slightest doubt that the record of the present meeting would be turned up by the historian as one of the milestones in Empire development. He left the audience to judge from Col. Crosthwait's lecture whether or not that prediction was likely to come true.

The following paper was then read:—

AIR SURVEY AND EMPIRE DEVELOPMENT.

By Colonel H. L. Crosthwait, C.I.E., R.E. (rtd.)

By way of introduction, I should like to say how appropriate it is that a paper connected with Survey and Maps should be read before the Royal Society of Arts. Perhaps it is not generally known that in order to encourage map-making in England, this Society offered premiums and medals for maps of the counties of England as far back as 1759. These awards only ceased about the year 1802, when the first one-inch maps of England, brought out by the Ordnance Survey, began to appear. I believe that awards were given for

the maps of some thirteen counties of England, so that this Society already saw the advantage of maps long before those in authority did, as the Ordnance Survey really dates from 1783, when the triangulation of the country, on which the topographical maps depend, was begun, with the measurement of a base on Hounslow Heath by General Roy. That was 24 years after the Society first began to offer awards for maps of England.

The last time I had the honour of addressing this Society my subject was the Survey of India, and dealt with normal methods of ground survey. That was nearly five years ago, and even in this short time things have advanced a great deal, and now I wish to speak to you about air survey and its bearing on Empire development—that is to say, the photographing of the ground from the air. From such photographs, in combination with points fixed on the ground, maps can be made, and also a great deal of other useful economic information can be obtained.

Mr. Amery, in his very interesting address to the last Imperial Conference, referred to the necessity for the scientific development of the almost unlimited resources of the Empire. We have heard a great deal lately about "buying Imperially," but we cannot buy Imperially until the Empire produces what we want in such quantities as will satisfy our needs. Experts tell us that, since the Empire possesses every variety of climate and soil, it is possible to produce, within its limits, everything we could possibly require; yet, according to the latest returns, only about 38 per cent. of the total imports of food stuffs and tobacco into the United Kingdom are derived from Empire sources. It seems, therefore, that there is still very considerable room for the development of our resources before the Empire can nearly supply all we want to take. This can only be done by bringing into production those large tracts of land which now lie idle, and which, if worked, would provide occupation for a large proportion of the surplus population of the older, overcrowded countries. It is indeed extraordinary that we should hear so much of making our Empire self-supporting while comparatively so little is being done to ascertain the possibilities which lie dormant in that Empire.

As an essential preliminary to economic development maps are necessary. Without them we cannot really begin to gauge our economic resources in forests, minerals and agriculture, nor can we properly allot areas to those who are anxious to occupy them, or tackle those engineering problems which go hand in hand with economic development, such for instance as the construction of roads, railways and irrigation works, and the investigation of hydro-electric schemes.

Without maps the overlapping of boundaries is inevitable, eventually leading to litigation and other inconveniences, with consequent waste of money. Surveys and maps should precede development and not follow it, if it is to be efficiently and successfully carried out. Unfortunately, this is a truth which does not always impress itself as much as it should on the official mind, though

there are exceptions. We can only suppose that this is due to the fact that expenditure on survey does not give a direct and immediately self-evident return. To grudge this expenditure is like starving a business by not supplying it with sufficient capital to carry it on at a profit. The Government which has a record of proper surveys and maps, and knows what it has to offer, is much more likely to attract immigrants and capital than one which can only supply imperfect information concerning its own resources.

The total area of the British Empire is nearly 14,000,000 square miles, and if we consider a country as *surveyed* if it is covered by $\frac{1}{2}$in. to the mile or larger scale maps, executed on scientific lines by an established survey department, then we find that only about 20 per cent. of the whole area comes within this category. These figures show how little has been done As an instance of our omission to map our own colonies, we have been in occupation of Jamaica since 1655, just 273 years, yet there is not a single map of the island which is of any value. I believe I am right in saying that the only considerable unit of the Empire which nearly fulfils the conditions I have just laid down, excepting of course the United Kingdom, is India. I may say that in the Colonial Survey Committee, we have an advisory body which strongly advocates the necessity for Empire survey. Its annual reports are most instructive, if not very pleasant reading, only because they show how little has been done.

I propose to try and indicate to you in what ways aerial photography can assist towards the scientific development of the Empire. One great disadvantage of the production of maps by normal survey methods is its extreme slowness. Some officials may hesitate to launch a scheme which will not be completed in their time. There are certain to be other rival schemes which will mature much sooner; it is only natural therefore that they should be favoured. This particular drawback, however, is fast disappearing, as by the use of air photographs it is possible greatly to speed up the mapping of any given area. The photographs can be taken at the rate of some 80—100 square miles a day, which means that we have down on paper all the topographical details of the ground in an extremely short time.

I do not mean to say that all ends there. Points have to be fixed on the ground in order to form a framework to control the photographs which have been taken from the air, both as regards planimetry and height. The extent of this framework depends on the nature of the country under survey, but certainly much less ground work would be required than in the case of normal survey. Then the photographs require a certain amount of interpretation, object names have to be collected and, of course, maps have to be drawn and printed embodying the detail derived from the photographs after it has been duly reduced to the proper scale. But all this work progresses very rapidly once the photographs are taken. From the fact that the photographs are taken from the air, it is not so material whether the country would be classed as easy or difficult for normal methods of survey. For instance, it is just as easy to

photograph forest country from the air as it is to photograph open spaces. The air method also involves a minimum amount of work on the ground as the photographs themselves provide all the topographical detail, so that in unhealthy areas the ground staff is reduced to the lowest possible number, and remains for the shortest possible time in the locality, most of the work being done in the office.

Let us now consider in general terms how this air survey is carried out. When it is decided to undertake the survey of any given area, it would be

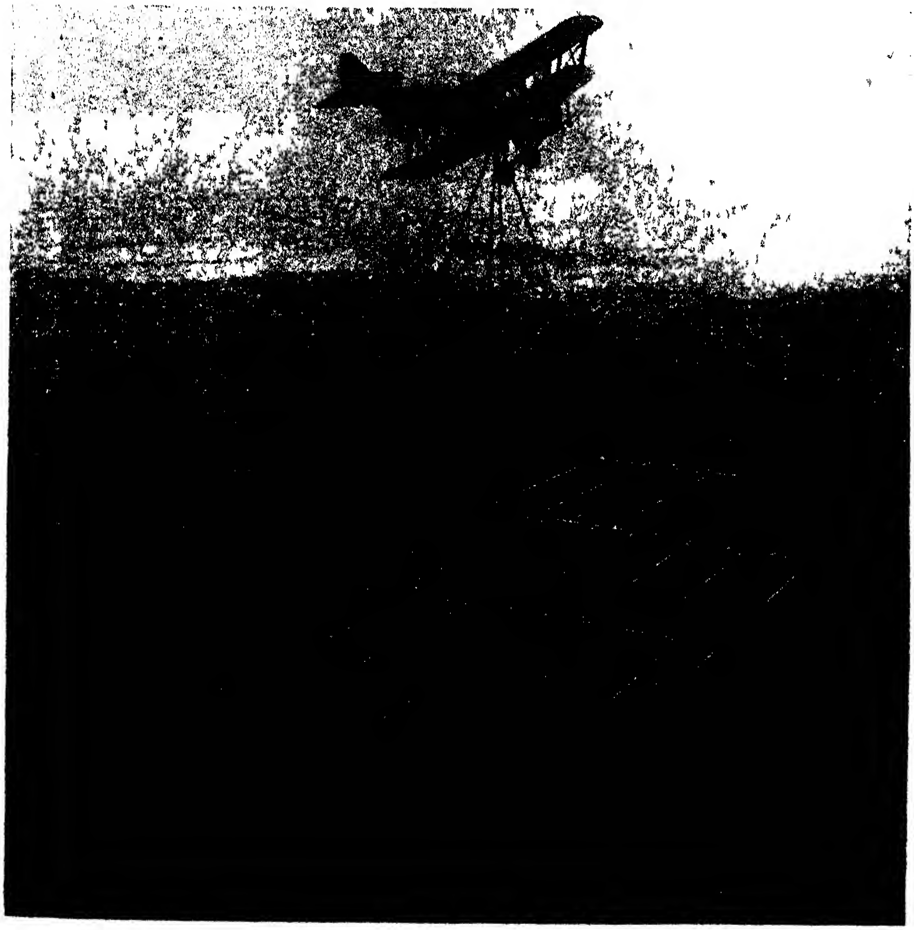

FIG. 1—Aeroplane taking overlapping photographs.

divided up into suitable sections. These would be covered by vertical photographs taken from an aeroplane flying over the sections in parallel straight lines. A specially designed, electrically driven, automatic camera is used for this purpose, an example of which, made by the Williamson Manufacturing

Company, is on view. It is known as the "Eagle" camera. These cameras, using films giving a picture 7in. x 7in., are capable of making 100 exposures on a single roll. The photographs would be taken with a 60 per cent. overlap in a forward direction and about a 30 per cent. overlap in a lateral direction, so

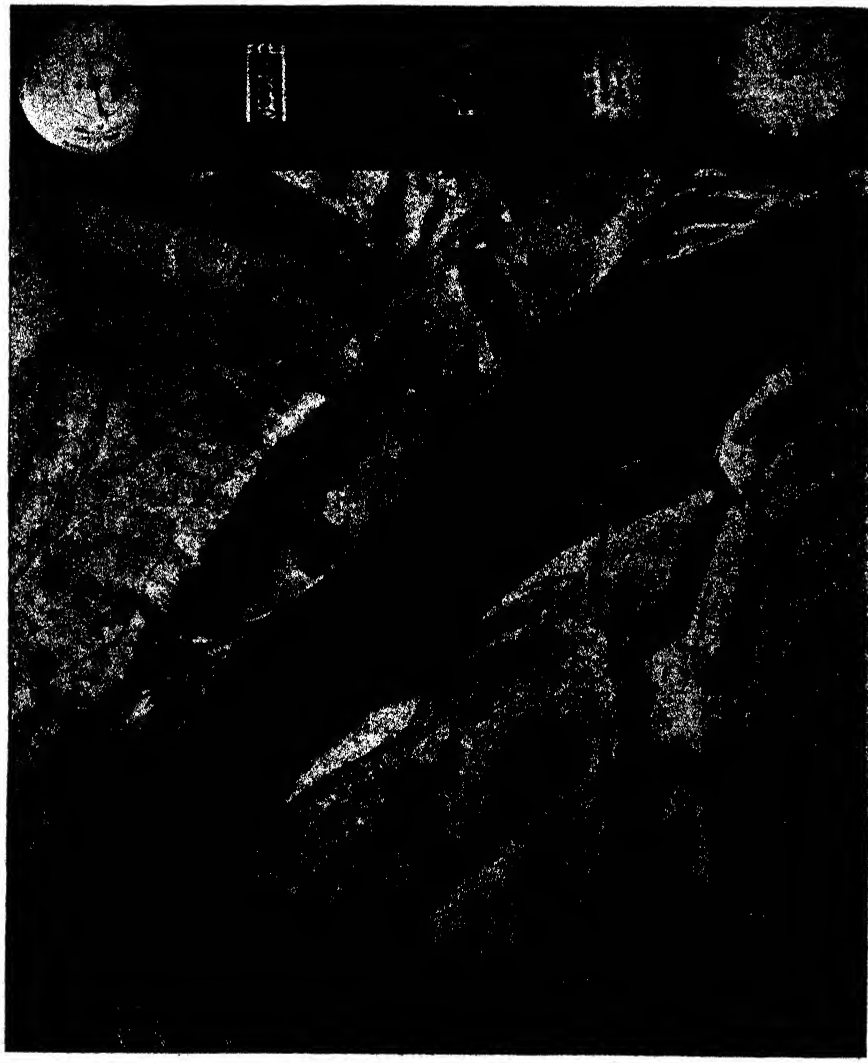

FIG. 2.—Single photograph showing instruments.

that the whole area would be covered by a series of overlapping photographs forming parallel strips which themselves overlap with neighbouring strips. Figure No. 1 shows in diagrammatic fashion how this is done. Figure No. 2 indicates what the photograph as taken looks like. When the photographs

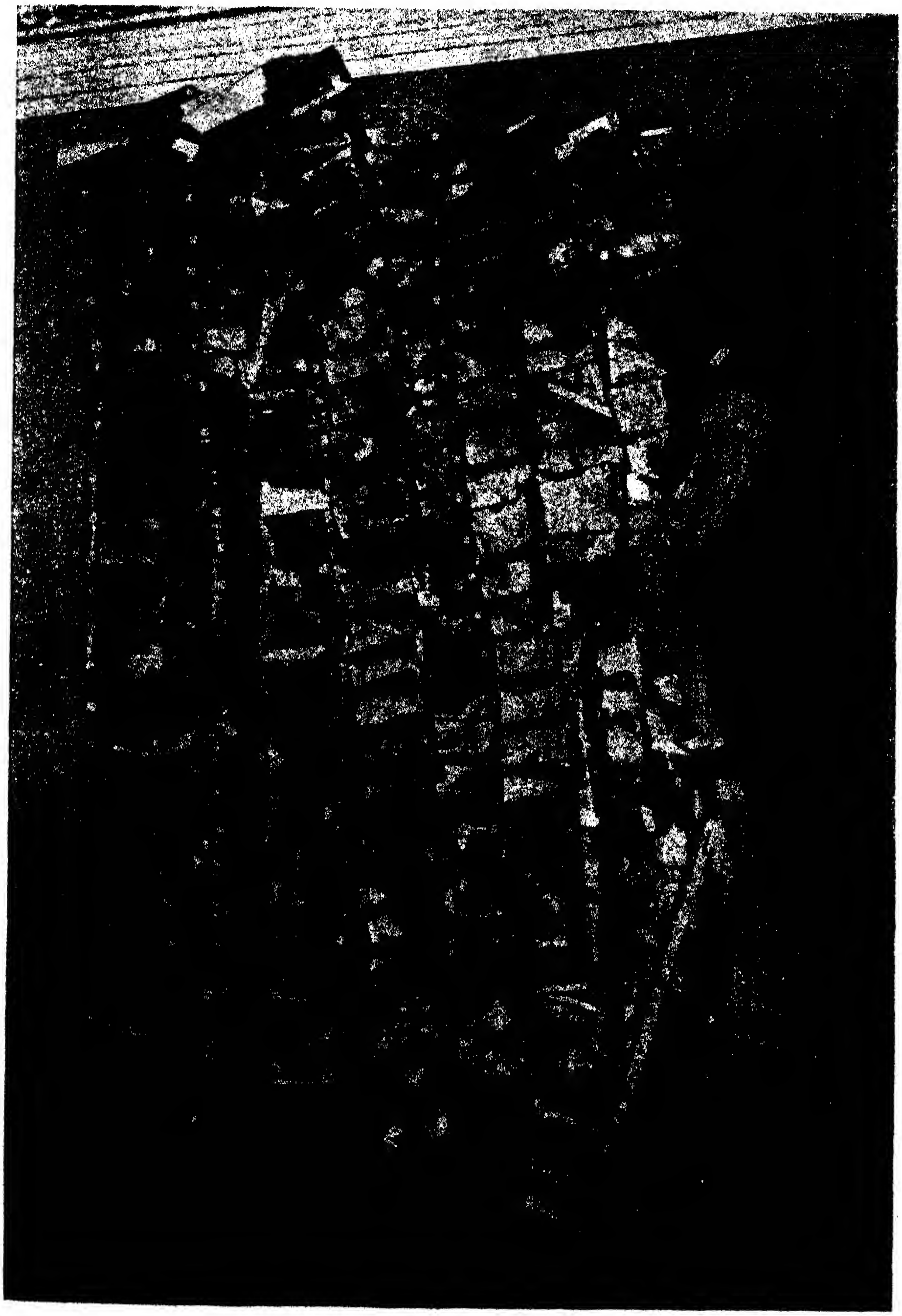

FIG. 3.—Joining up photographs to ascertain if whole area has been covered without gaps.

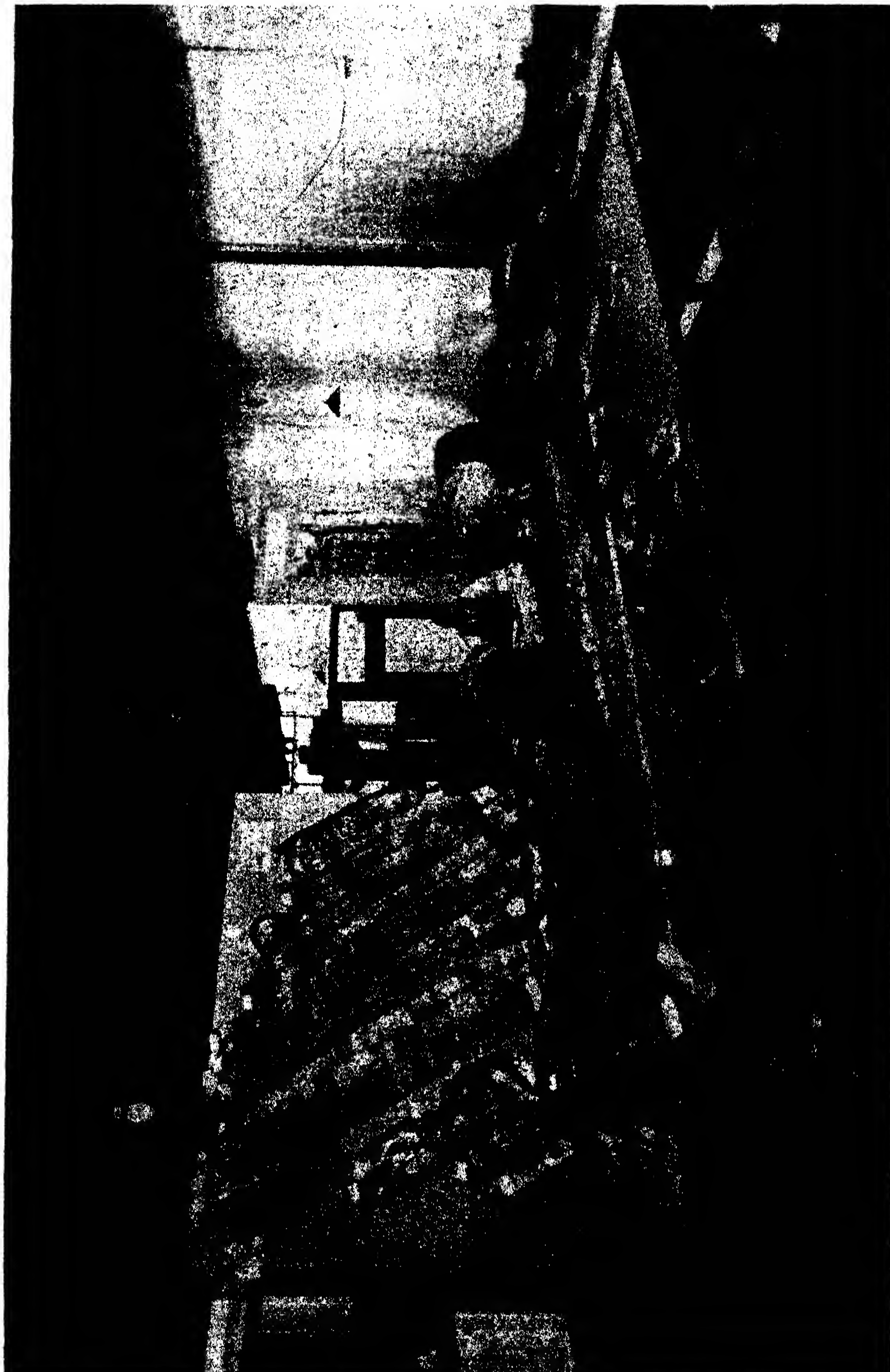

FIG. 4.—Plotting maps from aerial photographs.

have been developed and prints made in order to ascertain that the whole area has been covered without any gaps (see Figs. 3 and 4), they are then roughly joined together in conveniently sized sections and are given to the field surveyors, who fix suitably placed points for purposes of control, which can be easily recognised both on the photographs and on the ground. They also classify objects such as roads, etc., interpret any doubtful items of detail and collect the object names required for the final map. This fixing of points on the ground can be done by triangulation if the country is suitable, but often areas selected for air survey are wooded, intersected by waterways, or otherwise difficult and expensive to deal with by ordinary methods, so that it is now usual to fix points by astronomical observations, that is, to determine their latitude and their longitude by wireless time-signals. This has been made possible by the broadcasting of Greenwich time-signals which can be picked up with suitable apparatus in any part of the World. This process, unlike triangulation or other normal methods, does not require the expensive and slow clearing of lines for the surveyor. In this connection, a comparatively new instrument, of French invention, has come into use for finding both latitude and local time in one and the same operation, called the Prismatic Astrolabe, an example of which, modified by Mr. E. A. Reeves, is here for you to see, made by Messrs. Casella. There are also specimens of survey wireless time-receivers made by Messrs. Marconi. At the same time, the ground surveyors also fix a number of heights in suitable places for the eventual contouring of the finished map.

In the first instance, heights would be fixed by means of batteries of aneroid barometers, an example of which is kindly shown by Messrs. Negretti & Zambra. Field readings would be controlled by continuous base observations. A new kind of aneroid known as the Paulin Barometer is also shown. This barometer shows considerable promise, though we have not yet tested it out. From the photographs thus obtained, in combination with the ground control, both as regards position and height, maps can be produced.

Another method has also been employed; instead of taking vertical photographs, oblique photographs are taken in such a manner that the horizon is visible in the picture.

Perspective grids are then applied to these photographs and the detail is transferred on to squared paper as illustrated in Fig. 5. This method is not suitable to every class of country. The ground should be flat and the horizon must be visible when the photograph is taken. It is a method which has been largely used in Canada, where the country is flat and particularly suitable, and the topographical features are large, and where maps on a small scale only are required. But there is no doubt that it has great possibilities in new countries where large areas have to be surveyed at a cheap rate, and where the ground is favourable.

The stereoscope, an example of which, made by Barr & Stroud, is on the table, is an instrument which has proved of the greatest value in plotting

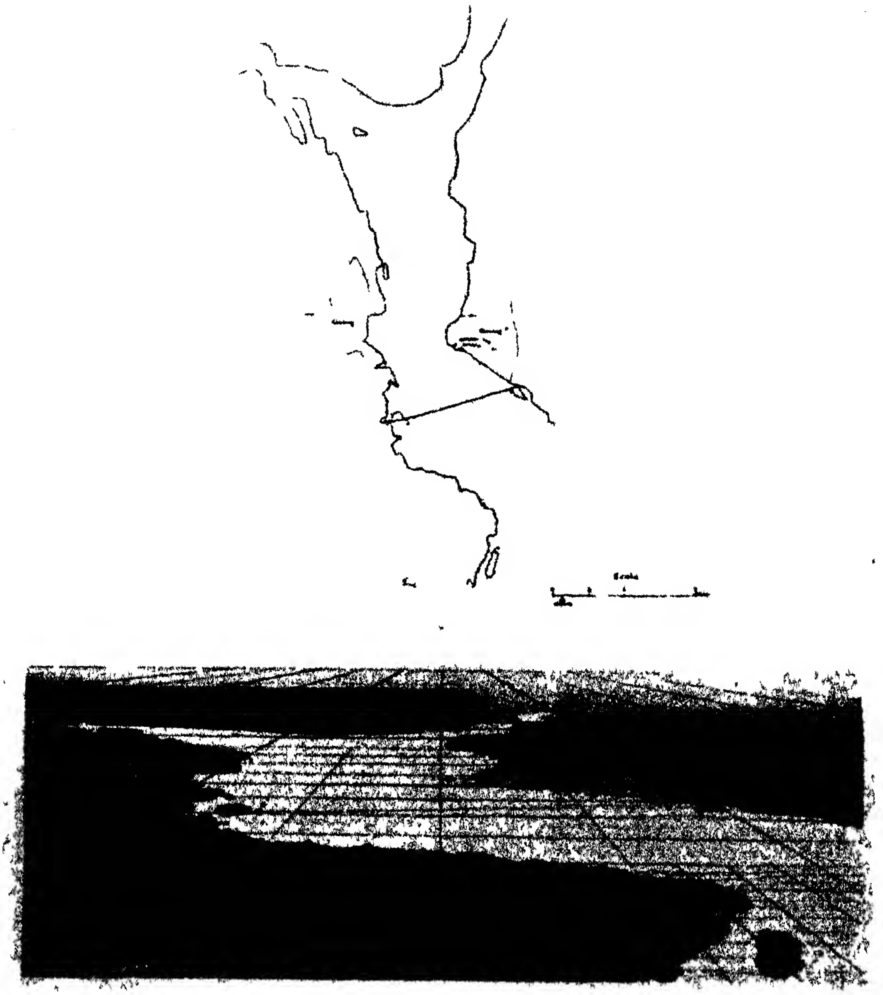

FIG. 5.—Oblique photograph and resulting map.

and contouring maps made from air photographs by a method sucessfully developed by Capt. Hotine, R.E. Pairs of photographs which are taken with a 50 per cent. and more overlap, can be used for examination in this instrument, the effect being that we see a model of the ground in perfect relief. It is astonishing how much detail which is missed in an ordinary photograph can be seen. Besides its use for mapping, the stereoscopic viewing of vertical photographs has advantages for engineering purposes not afforded by any other method. The engineer can examine at leisure in his office what is equivalent to a model of the ground in which he is interested exact

in every detail. It is safe to prophesy that in the future every engineering scheme of any importance will have the site with which it is concerned photographed from the air for stereoscopic examination.

Let me indicate shortly some of the other uses to which air photography may be put in connection with economic development.

Air photography is extremely applicable to the location of railways in undeveloped or partially-developed countries, where either no maps exist or are on a small scale only, the object being to assist the railway engineer to decide upon the best and most economical line to construct. The faulty alignment of a railway may be the cause of very considerable and continuous loss to the owners and to the country through which it passes. While on this subject, I should like to quote the remarks of a distinguished Colonial Governor, who is also a very experienced surveyor, during a discussion following a paper read last year in this theatre, though not before this Society, but before the Institute of Aeronautical Engineers. He said:—

> "Up to the present our tropical Colonies have had to make shift—when "we have had to make roads, we have made them whether a contoured map "existed or not; the same thing applied to railways. The other day we spent "one-and-a-half millions in straightening out the railway between the coast "and Coomassie, which had been constructed before a map was made. If "you can get a photographic map first, you are going to save yourself literally "hundreds of thousands of pounds in road or railway construction, but if you "are going to conduct that survey by working through forests it is going to take a "long time: on the other hand, if your air survey company can get a decent "photographic contoured map of the country, it will be a good and quickly "made guide, and will greatly help the Colonial Government of a tropical country "in its work of developing railways and roads."

About a quarter of the sum wasted on this particular railway, owing to an attempt to develop before maps were made, would have more than sufficed to survey the whole of the colony and to provide it with a set of maps which could have been used, not only for railway and road construction, but for general economic and administrative purposes. It is an example of the uneconomic result of *not* mapping before development. It should be mentioned however that this railway was made before the days of air photography.

This question of the location of railways by means of air survey is so important that it is worth a few moments' consideration. For purposes of illustration, let us suppose that three possible routes or alternative alignments for a railway have to be examined, with a view to deciding which is the most suitable from an economic and engineering point of view. Each line would be photographed from the air with a 60 per cent. overlap. Mosaic strips would be made, brought to scale, and adjusted by making use of all existing control. These strips, together with a set of contact prints, would be submitted to the Chief Engineer for examination and viewing in the stereoscope. From such examination he would be able to decide which appeared to be the most suitable one of the three routes. Having done this, he would order it to be contoured. The

photographs of the route would then be taken in hand by a small ground party, which would determine heights at points selected as being the most suitable for stereoscopic contouring. This would be done by men walking over the ground with a battery of aneroids such as I have already mentioned. They would also provide any extra ground control which might be required for scaling the strip. Using these heights, the route would be contoured by means of the stereoscope, and again submitted to the Chief Engineer, who would most likely be able to decide the line to be finally surveyed by the railway field party, using normal methods. Alternatively, the Chief Engineer might order the contouring of one of the other routes before coming to a final decision. The determination of the necessary heights for purposes of contouring can be very rapidly carried out in the field. The photographs, aided by the stereoscope, would also afford a great deal of information regarding bridging and other engineering works which may be necessary. It is estimated that by this means the reconnaissance location surveys, for the purpose of discovering the best route, could be carried out in one quarter to one-fifth the time required by normal ground methods, and at much less cost.

Among the engineering uses to which air photography can be put is the investigation of water power development, water storage for irrigation purposes, and allied engineering projects. It has been found that the feasibility of a water power scheme, involving storage of large quantities of water, necessitating the submergence of considerable areas of land, could be ascertained from the study of air photographs in the stereoscope, with a very small amount of ground work. I do not mean that no field work whatever would be required, but the stereoscopic study of overlapping photographs will reduce it to a minimum and enable the engineer to make his preliminary report after only a few measurements taken at ruling points. This means that the preliminary reports can be prepared in a much shorter time and at less expense than has hitherto been the case. The method assumes a special importance in situations difficult of access on the ground, in view of the fact that so many hydro-electric schemes are often situated in such places.* The photographs taken for the preliminary investigations could be utilised for the final plans merely by adding to the ground control—it would not be necessary to re-photograph. As an example of the practical application of air photographs to schemes of this kind, I may instance the case of a power scheme connected with Lough Neagh, in Ireland, the perimeter of which, 85 miles in length, was photographed by Aerofilms, Ltd., in a single flight, showing the height of the water at a certain flood level, and the land that was submerged. From these photographs, and the detail common to them and the Ordnance Survey maps, it was possible to lay down on the map the water level contour before it had time to vary, with the least possible delay and at a comparatively small cost. Instances of this kind often crop up when cases have to be prepared,

*See Report Canadian Air Board, 1927.

generally in a hurry, for presentation to Parliament. The location surveys for electric power lines and pipe lines can also be rapidly carried out from the air.

With regard to the use of air photography in relation to the economic development of new countries, Mr. R. Bourne, of the Imperial Forestry Institute at Oxford, has recently brought out a most interesting and important pamphlet dealing with this subject, to which I should like to draw special attention. In it he describes the results of his investigations in Northern Rhodesia, using air photographs which were originally taken by the Aircraft Operating Company's expedition in that country, under Major C. K. Cochran-Patrick, D.S.O., M.C., for the Rhodesian Congo Border Concession, Ltd., who kindly allowed the photographs to be used. To quote from this pamphlet, he says "The future prosperity of the British Empire depends a good deal upon the economic development of the agricultural, forest, and mineral resources of the Colonies, India, and the Dominions." His experience in Rhodesia leads him to the conclusion that an air survey can contribute towards economic development under the following heads, namely, by indicating :—

"(i) The geological formations in sufficient detail to serve as the basis for the "production of geological maps.

"(ii) The localities in which mineralization is likely to occur.

"(iii) The zones in which, as a whole, the soil conditions are exceptionally "favourable for agriculture as practised (*a*) by the European and (*b*) by the "native.

"(iv) The zones in which the forests ought to be reserved for commercial or "protective reasons.

"(v) The correlation existing between the tsetse-fly and climate, geology, "soil, vegetation, fire, game, and man.

"(vi) The alternative alignments for the further development of roads and "railways, with a view not only to economy in construction and maintenance, "but also to the tapping of potentially productive areas."

This list gives plenty of food for thought for those who are interested in Colonial development, both Government officials and private individuals, and indicates the importance of the weapon which air survey has placed in their hands. Fig. 6 shows a photographic strip of country on which the forests have been classified by Mr. Bourne.

It would be impossible to deal with all the various applications of air photography such as the revision of existing maps on which the Ordnance Survey has been carrying on experiments during the last few years. Local Councils have also used it for bringing up-to-date maps for housing and similar schemes.

At the present time we are carrying out an extensive survey on a large scale of the City of Rio de Janeiro, in Brazil, for town-planning and extension purposes.

The question may well be asked what influence will this new method of photographic surveying have on the form of the map of the future. Is it not possible that the map of the future will be a photographic representation of

FIG 6 —Classification of growth by means of aerial photographs

the ground, on which have been surprinted certain conventional signs and colours, so as to indicate what the objects are, and to make it easier to read? For instance, we can imagine a photographic map on which the roads had been classified by means of some conventional sign or colour, just as they are on the ordinary maps to-day. I believe that such maps would be of very great interest and practical value, when applied to suitable ground. One difficulty about such an arrangement would be the reproduction in large quantities. This is a question for the consideration of the expert map-printer and process worker. But it certainly seems to me that there are possibilities in that direction worth considering. We are trying experiments at present with a photographic map of London.

Only the other day one of our most experienced surveyors made the following remark, which I think is worth repeating. He said: "I can recall no more striking lesson from all my experience than that the surveyor in laying his plans should always take the longest view. I think this is the more important because experience also shows that those whom the surveyor serves seem to have, in respect to maps, an inveterate propensity for hand to mouth arrangements."

It is this short-sighted hand to mouth arrangement which is the bar to all real progress of economic surveys intended to assist development.

For the survey of a country to be really effective, and promote the interests of development to the fullest extent, it is necessary that all government departments should co-operate so that all the information required by each one of them should result from the survey.

DISCUSSION.

The Chairman, in opening the discussion, said he felt sure that the audience would agree with his statement at the opening of the proceedings that the present meeting would be one of the milestones, not only in the history of the Society, but in the development of a new form of technology. When he read the proofs of the lecture he felt that he would have some nervousness in expressing the opinion that, as an essential to economic development, maps were necessary. He would just as soon think of going before a meeting of the Public Works Department and saying that, before starting a building, an architect's plan was necessary. The author went on to show that in Colonial development it was necessary to abandon the foolish policy of development in advance of the maps. The reader of the paper had referred to the striking case of Jamaica. He (the Chairman) thought it ought to be said, in fairness to those officials who worked in the West Indies, that there were instances of West Indian Colonies shewing enlightenment in the matter of map-making. Trinidad was warned before the war, owing to oil development, that accurate maps were necessary, and as soon as possible after the war that question was taken up. A party of Royal Engineers, under Captain Lathom, was sent to undertake the survey of that island and Tobago, on a scale of 1 in 50,000. That map had been carried on by the remarkable industry of Mr. McGillivray and was now ready for publication; as a matter of fact he believed some of the sheets

had already been published. But that was an outstanding spot in the West Indies, and among the Colonies generally what Col. Crosthwait had said in criticism of the policy that had existed was by no means exaggerated. He recently turned up the Blue Book containing the Report of the Hon. E. F. L. Wood, M.P. (now Lord Irwin, Viceroy of India), who visited the British West Indies at the end of 1921 as Under-Secretary of State for the Colonies. He reported very favourably on the potentialities of British Guiana, the following being a very striking extract from his Report :—

"British Guiana is a vast virgin forest country with resources in land, timber, minerals and water-power lying idle and unharnessed. It is part of the great fertile belt of tropical South America awaiting development. Although as large as the whole of Great Britain, it has a population less than that of Hertfordshire, and a cultivated area about one-fifth of the size of Kent. The present cultivated area consists entirely of a strip of coast-land varying in depth, but not usually, except along the fringes of the rivers, extending more than five or six miles inland. . . . As the interior is largely unsurveyed, it is impossible to speak with certainty as to the quantities of these materials that may exist. There is no doubt, however, that the potentialities of the hinterland are great."

When it was realised that British Guiana has been in possession of this country since 1814, and that the report he had quoted represented the results of British development work, it indicated that the survey of the country had been greatly neglected. Only 95 miles of railway had been built during the 114 years British Guiana had been in the possession of this country, and those facts showed how little this country knew of its possessions and how little it had done in this instance to develop the land that had been entrusted to it. The lecturer was perfectly right in drawing attention to that phase of work in Colonial development, and still more he was justified in giving a warning that survey should come first. If the survey had been undertaken no doubt development would have proceeded on quite different lines. The reader of the paper had produced a new instrument for surveying which had not the objections of the old one. He saw a good many gentlemen present who had suffered, as he had done, by attempting to do survey work in thick tropical jungle, where every foot of the ground had to be cut in front in order to make a line. It was well known how laborious that work was in the tropics, but the reader of the paper had shown that at last an instrument had been made which was not a mere toy, which could be used for serious quantitative survey work, and which could overcome the great difficulties that had hitherto been experienced. The method that had been described so graphically was one to which he thought they were largely indebted to archæologists. Far away back in the eighties, Major F. Elsdale experimented with balloons in the hope of detecting archæological remains; and subsequently Mr. Wellcome used anchored kites on the Upper Nile to photograph, by vertical photographs, the remains which he had been working on in that area. Probably the next important step in that direction was undertaken by Col. Beazeley in Mesopotamia in 1917. Col. Beazeley then showed that, from vertical photographs taken from aeroplanes, he obtained outlines of ancient cities, with the ordinary arrangements of streets and houses, in a way that never was suspected by ordinary observation on the ground. Many present would remember the excellent work done after the war, he was going to say accidentally, but certainly surprisingly, by Air-Commander Clark-Hall and Flight-Lieut. Haslam in Hampshire. By air photographs they discovered traces of ancient workings which never before had been suspected by surveyors walking over well-cleared ground. There then followed the

remarkable series of photographs of Stonehenge taken by Mr. Crawford, which made the alignment of the eastern avenue to Stonehenge perfectly visible. Anyone who had seen the photographs would realise that the camera in the air had provided an instrument which enabled them to see things which it was not possible to see whilst surveying on the surface of the ground. Mr. Bourne, to whom Col. Crosthwait had referred, spoke of the difficulty in a tropical country of making a survey on the ground because of the way in which the wood was hidden by the trees. That was perfectly true, but the reader of the paper had given an entirely new view of that old proverb, for the camera in the air had shown that the distant view was necessary to convert chaos into order. The physics of the camera in the air were extremely interesting. Their investigation arose from a series of problems that were first worked out in connection with the submarine. Many of the audience would remember how from aeroplanes it was possible to detect submerged submarines when they were not, for quite obvious and physical reasons, visible to the cruisers and scouts on the surface of the sea. The same thing had occurred with regard to the detection of ancient marks in connection with archæological works. A growing crop, especially a young crop, would show a slight difference of colour and a slight difference in its rate of growth over an old excavation on the chalky plains of Salisbury. That came out most perfectly from the air, and was seen very plainly in the photographs in a way that no one would detect in walking over the grassy downs of Salisbury Plain. The method Col. Crosthwait had described had been used largely in South Africa, the land which appeared to breed the spirit of enterprise. It was used during the war in Portuguese East Africa, and new routes were detected that never before were suspected to exist. It was used in German South-West Africa after the war in the mandated territory, when Professor Schwarz, of the Rhodes University College of Grahamstown, proposed that a survey should be undertaken of Ovamboland, in order that there might be a possibility of working out a scheme for the diversion of the River Kumene, which now ran into the Atlantic Ocean direct, and which could be easily diverted eastward into the old half-dry lake Etosha, thus saving from complete desiccation a large and valuable area between the basin of the Orange River and the present Kumene. Some of those present would remember that in 1922 Dr. Chalmers Mitchell, the very able and popular Secretary of the Zoo, in an aeroplane trip in Africa from north to south, detected the occurrence of volcanic rocks north of Khartoum which had not previously been detected by the ordinary surveyors. That was another fairly good illustration of the way in which an aeroplane survey could be utilised for reconnaissance work in geology. He also desired to say a word of appreciation of the memoir which Mr. Bourne had produced as the result of a specialised study of photographs taken in Northern Rhodesia. That was an example of a very detailed and special study of a series of photographs undertaken by a forestry expert, and Mr. Bourne had shown in his Memoir what an enormous amount of valuable information could be obtained from photographs taken so quickly. Those who had served in India would recognise Mr. Bourne as the son of Sir Alfred Bourne, the distinguished biologist, who was the Director of Public Instruction in Madras. The only other remark he desired to make was that he thought all present would agree thst the remarkable way in which the mere taking of photographs for amusement had passed into a serious and definitely systematised science was largely due to the enterprise of Mr. Alan Butler, the Chairman of the Aircraft Operating Company, the company which was responsible for the photographs of South Africa. It was due to Mr. Butler's enterprise and readiness to expend large sums of money that the method had

been brought to such a striking success. He desired, in conclusion, to express from the Chair his appreciation of the extraordinary results which the reader of the paper had brought to their attention.

Col. Sir Charles Close, K.B.E., C.B., Sc.D., F.R.S. (late Director General, Ordnance Survey), said that he was in almost entire agreement with the whole of the lecture. He agreed with what had been said that the development of Empire surveys ought to be taken up by those who were responsible, and he could not think of any method which was likely to give the desired results more readily and at less cost than a free adoption of the air survey method. He did not desire that remark to be taken as meaning, however, that the air method was of universal application. It was certainly not as useful, for instance, in hilly country. The method had not yet been thoroughly worked out. The Orange River Colony was mapped by Col. Winterbotham at a cost of £18,000, the time occupied being five or six years, and he did not think in that particular case better results would have been obtained if air photographs had been taken. He desired to emphasise that the new method must be used with reasonable discrimination. The Chairman had mentioned that Col. Elsdale in the early days took a great interest in air photographs for survey purposes. He (Sir Charles Close) served under Col. Elsdale for a year or two, and he had in his possession a photograph which he took about 1883 of part of Halifax, Nova Scotia. In that respect he desired to correct a remark the Chairman had made. Col. Elsdale's activities were entirely directed towards military purposes; he was not an archæologist at all. Col. Elsdale used to send up small balloons seven or eight feet in diameter with a camera attached to them and automatic release apparatus. The balloon went up 1,000 feet, released the automatic apparatus, and then came down wherever the wind chose to blow it. Very good results were obtained in that way. The case of Jamaica to which the Chairman had referred was even worse than had been stated. In 1905 the Colonial Survey Section was actually in Jamaica ready to make a map. The Government at home was ready to go shares in the cost of making that map, but the local Government would not do so, and as a result the Survey Section was sent to the Orange River Colony! The new method had shown its value, but it was not at present of universal application. There were still things in the old methods which were very valuable, and, as the reader of the paper had stated, it would not be possible, as a rule, to rule out the necessity for ground control.

Col. H. St. John Winterbotham, C.M.G., D.S.O. (Geographical Section, War Office), emphasised the immense importance of quick and fairly accurate reconnaissance surveys for roads and railways. Such a reconnaissance survey had recently been made of a particularly deep and difficult gorge in the heart of Africa, some forty miles long and very difficult to survey, at a cost of something like £2 a square mile, practically without any ground control worth mentioning, and at about one-tenth of the cost which would have been incurred by old ground methods. From the point of view of the alignment of railways and roads alone the new method had justified its use. This country now stood pre-eminent from the point of view of air survey, because it had been developed by the proper people. On the continent and elsewhere it had been pushed by the two extremes; on the one hand, by the scientific instrument maker, and on the other, by the airman. Here it had been developed by surveyor and airman in conclave. As a consequence the Continent had machines which weighed five tons from which doubtful results were obtained, or a mere mosaic. In England an instrument was used which

weighed only 7½ lbs. The 3-inch maps which were now being made by the War Office would set a new standard for the fidelity with which the ground was followed, and the amount of surface detail which the photograph enabled them to achieve. Col. Crosthwait had referred on several occasions to the trouble experienced in penetrating dense forests from a photographic point of view. It was the first axiom in any survey that the surveyor must see, and in many of the trials in densely afforested countries in the East the camera had been powerless to pierce the screen of tropical vegetation which hid the land forms underneath. As Sir Charles Close had said, there were occasions when the air survey method would not work, but on the other hand there were many occasions when it did.

MAJOR C. K. COCHRAN-PATRICK, D.S.O., M.C., said the Chairman had referred to British Guiana as one of the instances in which the Empire could have been developed in a better way. Personally, he spoke feelingly of British Guiana, because he was stranded in the middle of it one Christmas Day owing to damage caused to one of his flying boats, and as a result spent an uncomfortable week in the middle of the jungle. The instance of British Guiana only served to show how essential it was that not only should the Colonies be expected to carry out surveys, but that the Imperial Government should help in their cost. British Guiana had a very small population and a small income, and could not be expected to incur the fairly heavy expenditure which was necessary to complete a really comprehensive development survey of the entire Colony. It was necessary for the Government at home to help the Colonies to carry out essential surveys. The Chairman had mentioned the work done by Col. Beazeley in Bagdad and Mesopotamia, and it was very interesting to note how, in the survey which was at present being made, the system of canals showed up on the photographs. There were most amazing systems of ancient canals which must at some time have irrigated extensive areas of desert which now were useless. It merely served to emphasise the fact that enormous areas existed in that country which could quite easily be developed, as they had in the past produced useful crops. An unfortunate feeling seemed to exist that the air surveyor was in direct opposition to the ground surveyor, but that was not at all the case. Unfortunately, air survey began by airmen taking photographs and trying to piece them together in mosaics, but certainly in this country the airmen very soon realised that that plan was quite impossible, and they were now trying very hard to teach themselves to be ground surveyors. They were very glad when a ground surveyor came along and tried to look at things from the point of view of the airman and of the photographer, because it was only by a very close combination of the three essential elements, the flying side, the photographic side, and the drawing office side, that really efficient and economic results could be obtained.

In addition to the special instruments which it had been necessary to construct to meet the requirements of air survey, they had found it essential to design a special aeroplane.

This machine, which was at present under construction, would be capable of climbing to more than 20,000 feet, at which height it would still have a very high speed. It would be fitted with two engines but would be able to fly comfortably with either engine stopped without running the remaining engine at more than ¾ throttle. This should give it almost complete immunity from forced landings.

The pilot would be seated in the extreme nose, so that he might have the maximum possible view for photography, while the photographer and his cameras would be comfortably placed in a roomy cabin with direct communication with the pilot.

In addition the machine would be capable of cruising for 7 hours so as to be capable of working at a long distance from the main base.

BRIG.-GEN. E. M. JACK, C.B., C.M.G., D.S.O. (Director-General, Ordnance Survey) supported very strongly the remarks the lecturer had made in regard to the application of the new method to the development of the Colonies and Protectorates. The application of air photography to survey had given the surveyor a new and extraordinarily valuable instrument. That application of photography was probably the greatest single development that had taken place in the science of survey since it was practised, and those who were responsible for the administration of undeveloped areas ought to take advantage of the wonderful new instrument which had been placed in their hands. The Ordnance Survey had its own peculiar problems. They were not dealing with the development of a new country, but with the maps of a well-mapped and highly-developed country. Those maps were very intricate, and a great deal of ground work was necessary for the collection of names, the investigation of boundaries and so on, and it was very largely open to question to what extent, if at all, photography could be used in Ordnance survey work, which was largely the revision of those maps. They had been experimenting for two or three years and were continuing the experiments, but he was not yet in a position to say to what extent air photography would be useful as a permanent method, although he thought there was no doubt a great deal of field work might be saved by means of its use. Major Cochran-Patrick had referred to the supposed feeling of opposition which existed on the part of the ground surveyor to the air surveyor. As a ground surveyor he could assure Major Cochran-Patrick that no feeling of that kind existed, certainly at the present time. The only opposition ground surveyors ever felt was to those who imagined in the early days of air survey that it was going to abolish the old methods. That, of course, was simply due to ignorance. As Major Cochran-Patrick said, air survey was an addition to the old methods, and it was necessary for all concerned to work together, as he was sure they were only too anxious and willing to do.

MR. R. BOURNE (Imperial Forestry Institute, Oxford), emphasised the point made by Major Cochran-Patrick, that it was necessary in the development of aerial survey to have a maximum measure of co-operation. Personally he approached the question not as a surveyor, but as a forester. He had been interested more in the aspect of the interpretation of air surveys. He had followed with great interest the work of the Canadian Forest Service, and the point was worth mentioning that there was actually an air section of the Canadian Forest Service comprising its own staff and survey personnel. This section of the Canadian Forest Service had not only to deal with the question of fire protection work, which was proving of enormous value, but it was also employed both by Governments and by private pulp and paper firms for taking stock of the merchantable properties of the forest. It was perfectly true that, where there was a dense forest canopy, an air photograph would not penetrate, but at the same time it indicated very clearly the distribution of the different vegetation types. The view from the air gave an idea of the forest distribution and indicated how the forest could be sampled. If a perspective view of the problem could thus be obtained a relatively true idea was presented of what the forest contained. Having obtained a general idea of how to sample an area, the next step was to take the vertical and oblique photographs on to the ground and to ascertain what they showed. A forest officer could not be expected to be a specialist in all subjects, and he, therefore, suggested

that, with a view to the interpretation of the aerial photographs, when the ground-work was being done, specialists representing different branches should bring their experience to bear on the problem in the field, so that they would come to understand each other's point of view. If selected members of the field parties would then re-fly over the same area, they could, with the maps prepared by the surveyor, sketch with very considerable accuracy the distribution of the different forest types, obtain a clear idea of the geological formation, and often get a clear idea as to the distribution of different soils.

Air Vice-Marshall Sir Sefton Brancker, K.C.B. (Director of Civil Aviation, Air Ministry), in proposing that a hearty vote of thanks be accorded to Col. Crosthwait for his exceedingly interesting paper, mentioned that while the air operating passenger companies received a subsidy, the Air Survey so far had not cost the country a penny; and the best proof that the undertaking was a business proposition was the presence of the reader of the paper on the Board of the leading company in this country. Personally, he thought those concerned should be proud of the fact that the Air Survey had never been on the dole, but that those concerned had always paid themselves for the service rendered. The trouble about air survey was that it did too much work in too short a time, and the expense was often comparatively large in view of the overhead charges. If several Colonies could be induced to have air surveys made at the same time, so that the aircraft could be fully employed, the overhead charges could be distributed, and, as a result, the price considerably reduced. Col. Jack had referred to the question of the bringing up to date of the Ordnance Survey of this country. In that respect the Treasury limited the Ordnance Survey to so many square miles per year, which one aeroplane could do within three weeks. He was perfectly certain it would be a very good thing if the Air Survey could correct the Ordnance Survey every year from top to bottom, but the Treasury would not agree to that. One of the most efficient Air Surveys that had been carried out was that of Rhodesia, where aviation worked hand in hand with the ground organisation. There were skilled surveyors on the ground under the command of the Air Survey, and he believed that was what would happen in the future. He was not at all sure, either, that that predominance of the air was not what would happen in regard to war in the future. He agreed with the Chairman that Air Survey would be a very big factor in the development of the Empire. Every Colony and Overseas Dominion now realised that, if they could afford to make an Air Survey, it should certainly be carried out. He moved that a most hearty vote of thanks be accorded to Col. Crosthwait, not only for his paper, but for the pioneer work he was doing in a most important development.

The resolution of thanks was carried unanimously, and Col. Crosthwait having briefly acknowledged it, the meeting terminated.

Colonel C. H. D. Ryder, C.B., C.I.E., D.S.O., late Surveyor General of India and Chairman, Air Survey Company, had to leave before the discussion, and sends the following remarks :—

" It is somewhat saddening to realise that even now so much of Colonel Crosthwait's interesting lecture has had to be devoted to stressing the necessity of surveys and maps. It seems so obvious and yet it apparently is not so to many Colonial authorities.

I have seen it mentioned, I think, by Colonel Macleod, that it is a curious thing that while official surveyors have been dinning into the ears of Colonial Governments

the necessity of maps, the latter pay more attention to the proposals of commercial companies; if this is correct, I think it shows the advantage of having one method of surveying, air survey, carried out by companies and not by a Government department. The two names which should be mentioned in this connection are those of Mr. Alan Butler and Mr. Ronald Kemp, who have financed the two British companies through their early trials and experimental work.

I would only like to add how much I have enjoyed my old friend Colonel Crosthwait's paper, and how helpful the ventilation of this subject should be to all concerned.

NOTES ON BOOKS.

Impurities in Metals: Their Influence on Structure and Properties. By Colin J. Smithells, M.C., D.Sc. London: Chapman & Hall, Ltd. 18*s*. net.

Although the main relationships between composition and micro-structure in alloys have now for some time been established by metallographic investigation, it is only recently that due attention has been paid to what Dr. Smithells calls "minor constituents." By this term he simply means substances present in very small proportion. It makes, of course, no difference, from the metallographic point of view, whether such substances are present as accidental impurities or whether they have been added deliberately; and Dr. Smithells explains that he would have used the term "minor constituents" in his title if there had been no risk of misunderstanding.

The book is intended for those who are already familiar with metallographic work, but it commences with a brief and exceedingly lucid description of crystalline and metallic structure in general, and of the methods by which this structure is determined. Since the application of X-rays to the problem is of somewhat recent date, this subject is treated with greater fulness; and the chapter in question, while avoiding experimental and other detail, gives an unusually well-balanced and informative account of the principles on which the method is based, and of the broad conclusions which have resulted from it.

Microscopic and thermal investigations, though they still remain the principal means of attack, are more rapidly dismissed, presumably as being more familiar to the metallurgist; and the remainder of the book is devoted to a consideration of the effects, often disproportionately great, of the presence of foreign substances to the extent of about 1 per cent. or less.

From the industrial point of view it is the effect on the mechanical properties of the metal that is as a general rule the most important result; but this effect is always in close relation with a change in the visible microscopic structure, and is usually easily understandable when that structure is properly examined. Though it is not always practicable to make a very hard and fast distinction, it is possible roughly to classify the foreign substances as metals, non-metallic solids and gases; and in each of these classes a full account of the resulting structural alterations is given.

Apart from purely mechanical properties, there are, of course, others, such as electrical conductivity, resistance to corrosion, etc., which, in certain cases, assume considerable economic importance, and these are fully discussed in the two last chapters. Though lacking a bibliography, which indeed, would have to attain almost impossible dimensions in order to be of real value, the book is well provided with references, most of which are of very recent date.

EXHIBITIONS OF APPLIED ART.

Claridge Gallery. Exhibition of Decorative Art.—This is a small but comprehensive exhibition in which foreign work is displayed as well as British ; and much that is pleasing and desirable meets the eye at a first glance. The influence of Fitzroy Street is shown to be disseminated throughout the various provinces of decorative art ; Mr. Duncan Grant and Mrs. Bell themselves being represented by interesting painted screens. Their disciple, Mr. Douglas Davidson, has more than a little talent, and it would be doing him less than justice to say he was no more than " school of Grant "—though this would be a tribute to any young man's good sense. Mr. Davidson's embroidered table top in shades of grey is an excellent piece of work. His rugs are good also; on the other hand his screen, though strong, and in no way finnicky, has a touch of the uncouth ; the room where it would be in harmony would itself be out of tune for repose.

Mr. Rex Whistler, of Millbank refreshment-room fame, who rightly enjoys a discreetly solid reputation, is represented by what is described as a corridor panel. The style is that of the Millbank wall-paintings : ghostly figures flit charmingly in a picturesque landscape of dull green tones, the whole being seen through a classical portico. As a change from the bright and warring colours of some moderns, Mr. Whistler's conceptions are welcome ; the suggestion of respect paid to tradition, though gaily, is also a congenial touch. But is not this decorator like someone who, having found a perfect recipe for fricassee of chicken, is reluctant to serve up anything else ? It is hard to see on what lines this style is going to be developed ; it is at present not an altogether satisfactory end in itself.

The trees of glass and precious stones convey a strong feeling of luxurious refinement ; their æsthetic justification is not apparent, though they stir the senses. The portrait painted on glass by Mr. Messel is crude. Mr. Adrian Allinson has at least one curious and pleasing pot, of which one example is blue and one white (No. 55) ; the strange ribs being accountable for the vitality of the piece.

The standard of design shown by the artists responsible for the printed stuffs is high throughout ; indeed, this little exhibition is heartening ; there seems no department of decorative art in which healthy and even original influences are not at work. These influences could and should be much more widely felt. In Duncan Grant we have a painter and decorative artist whose name has in a most significant way already found its way into foreign text-books. The boldness and sureness of his design is not merely original ; in certain respects modernity is what he decides it should be. His genius, all craftsmen should observe, lies not in simply adding a little rouge and lipstick to the face of the utilitarian modern world, but in finding congruous methods of transforming something useful and ugly into something useful and beautiful.

Arlington Gallery. Exhibition of Modern Furniture. Russell Workshops, Broadway, Worcs.—The Russell Workshops are situated in the village of Broadway, the famous old-fashioned spot of which one interesting feature is the craft centre itself : blocks of cottages built on a logical and attractive plan from the designs of Leslie Mansfield. In this ideal environment is produced sound furniture, which, though not old-fashioned, is not too self-consciously modern. We see no particular straining after a modern style at the present exhibition ; the most up-to-date items are the very fine carpets of the Austrian designer, Resch, who works in co-operation with Russell's.

The modernness of the furniture consists in its simplicity, usefulness, and reliance

on the intrinsic æsthetic qualities of the woods employed. There is a handsome bookcase, No. 23, perfect, but for the pattern cut on the glass, an unnecessary disturbance of its serenity. The price is the large one of fifty guineas ; however, the air of slenderness and strength of the rosewood case with its inlay of ebony and rustless steel door-frames is very captivating. On the opposite side of the room stands a fine grandfather clock, also in rosewood, the general aspect of which is quite old-fashioned. Good work like this makes nonsense of " periods " ; the clock would not be out of place in many a decorative scheme whether of predominantly " period " or modern character.

Worthy of note are the yew-tree chairs which form part of a dining room set mainly in English oak. The lacquer bedroom set is not unattractive, though the decorations are ineffective. I understand this is the first time Messrs. Russell have experimented in this medium.

On view also are some of Mr. Paul Nash's charming printed stuffs. Messrs. Russell are animated by a liberal spirit ; not only do they keep in touch with artists like Mr. Nash and Herr Resch, but, as we read in Mr. Thorp's introduction to the show : " the men at the bench, and, *a fortiori*, the foremen, (i.e. at Broadway) are taken into consultation, and not infrequently adaptations of form . . . . are devised in the shops."

Mr. Thorp touches on the question of the place of machinery in the workshop. Reasonable minds do not condemn machines, but the too wide use commonly made of them. There is a point up to which machines support and help on the development of the human individuality. Beyond that point they are obstacles to such development. It is the very proper idea of Messrs. Russell that by the discreet use of machines the workman should be " spared some hard donkey work and set free for the more delicate and intricate problems of his job."

Russell workshops are a growing concern. Where possible they join to themselves craftsmen performing services auxiliary to their primary needs. Broadway has thus become an important centre for more crafts than that of the cabinet maker.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, JANUARY 1..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, " Sound Waves and their Uses, Notes and Noises." (Lecture III).

WEDNESDAY, JANUARY 2..Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Wireless Section Meeting. Messrs. P. P. Eckersley and H. L. Kirke, "The Design of Transmitting Aerials for Broadcasting Stations."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. G. Wilkinson, " Economic Application of Electricity to Low Temperature Heating Purposes."

THURSDAY, JANUARY 3..Linnean Society, Burlington House, W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, " Sound Waves and their Uses—How Sounds are Analysed." [Lecture IV).

FRIDAY, JANUARY 4..Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Major A. W. Farrer, " The Engineer Salesman Abroad."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 3.30 p.m. Dr. Hugh R. Mill, " Captain Cook's quest of the Southern Continent."

At Engineering and Scientific Club, Wolverhampton. 7.30 p.m. Mr. J. P. Fuery, " Patents for Inventions and their Relation to Trade."

Transport, Institute of, at Leeds. 7 p.m. Paper by Mr. Percy Beetham.

SATURDAY, JANUARY 5..Education Fellowship, New, at the Central Hall (Library), Westminster, S.W. 5.30 p.m. Sir Michael Sadler, " Examinations."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, " Sound Waves and their Uses—The Ear and What it Does." [Lecture V).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

NEXT WEEK.

THURSDAY, JANUARY 10TH, at 3 p.m. (Dr. Mann Juvenile Lecture). CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, "Ships and Lighthouses" (illustrated by lantern slides). Tea will be served in the Library after the Lecture.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 28TH, 1928.

THE RIGHT HON. THOMAS WILES, P.C., in the Chair.

THE CHAIRMAN, in introducing the Lecturer, said he was a member of the head-quarters staff of the Port of London Authority. An American would probably describe him as a "live wire." But what a field he had to cover in his subject of that evening! The river Thames, with the Port of London, was once described as seventy miles of "liquid history," from the little Nore lightship bobbing up and down in the North Sea right away to the respectable suburban district which surrounded Teddington Lock. The speaker had often thought that Londoners were very ignorant of their docks. Probably not 10 per cent. of the seven millions of people who inhabited Greater London had ever seen the Docks, and he doubted whether very many more had ever seen the river Thames—anyhow, if they had seen it, it was only as a grey stretch of water between Blackfriars and Westminster, or, perhaps, a golden stream between Maidenhead and Windsor. But he thought he could say without contradiction that if it had not been for the river Thames there would have been no London to-day. It was a unique river, because it had this wonderful tide, flowing backwards and forwards, carrying goods freely from

one end to the other, night and day, guided by no motor or steam power, but by the lightermen, who were most wonderful craftsmen, steering these vessels on the tidal way, up and down the river, alike in summer and winter, in fog and frost and any kind of weather. It was the river which had created the miles upon miles of factories and mills and wharves along its banks. In the old days the Egyptians used to worship the Nile, and the Romans Father Tiber. Londoners should make obeisance to Father Thames who had made their city the greatest city in the world.

How had the Thames been managed? He ventured to say, even before that audience, that the Thames had been mismanaged and muddled for centuries. It had been managed by conservators, docks directors, borough and county councillors, Trinity Brothers, in fact, so many overlapping authorities that it was almost impossible to manage the Port and the river Thames at all. About 25 years ago a Royal Commission was appointed, and reported in favour of a body which should have power to deal with the whole of the Thames, from Teddington to the Nore. The speaker well remembered the Bill in Parliament, because he had happened to make his maiden speech, very humbly and nervously, on that very Bill when it was brought up in 1907.

The Port of London Authority, which was created in 1909, consisted of 28 members, eighteen of whom were elected by the payers of dues, and ten appointed by the Board of Trade and certain public bodies. The members were elected for three years so that they should not get into an antiquated state like that of some other bodies. It was also a non-political Authority. There were no politics in the Port of London. He had never served on a public body which got on with its work as quickly, and quietly, and well as this Authority did. Since it had been established great marks had been made on the Port and on the river. The river had never been well dredged, and very large ships now came into the docks. The docks had been improved and modernized and brought up-to-date. The King George Dock—he believed the finest dock in the world—was one of the sights of London, and one which the Government always sent distinguished visitors to see. At present the Authority was making a landing-stage at Tilbury, so that the ocean-going steamer would come up to the landing-stage, and the train from St. Pancras would take passengers right along-side. Everything was being done to bring London up to the requirements of modern shipping. He ventured to say that to-day the modern machinery, the good equipment, and the efficient service made London an unrivalled port in the world, and there was no doubt that the Authority was carrying out the motto on its flag: "*Floreat imperii portus.*"

The following paper was then read:—

THE PORT OF LONDON.

By J. H. Estill, O.B.E., Commercial Manager, Port of London Authority.

It is often said that "comparisons are odious," and this, of course, is probably true of many things, but I hope I may be forgiven in this instance, as it is only by comparison that one is able to appreciate the relative commercial position of the various ports.

Whether the basis of comparison be the volume of tonnage of shipping entering its river, the weight and value of the commodities imported and exported, or the extent of its international markets, London has long been the greatest port in this country and probably in the world.

London was the principal port of Britain before it became the capital, and its greatness as a city has increased coincidentally with its commerce. Many circumstances have combined to effect this progress, but the chief are the geographical and physical advantages enjoyed by the port. London is about sixty miles from the sea, which makes it not only a safe depot for valuable merchandise, but gives it an advantage as a market and distributing centre for the United Kingdom. The mouth of the Thames faces the mouths of the Rhine and the Scheldt; the Elbe is not far distant. Continental trade between London and ports on these rivers is therefore easy.

The physical advantage of the port of London is its broad and deep river, enabling vessels of the largest class to enter its docks with facility.

The earliest reference to London in history is as a *port*. The Roman historian Tacitus, writing in A.D. 61, states that "Londinium, though undistinguished by the name of a colony, was much frequented by a number of merchants and trading vessels."

During the Roman occupation London became a depôt for luxuries required by the Roman settlers and for the export of corn to the legions on the Rhine. The London Stone, which is now enclosed in a stone case and built in the outer wall of St. Swithin's Church, Cannon Street, was in Roman times the central millarium, or milestone, similar to that in the Forum at Rome, from which the British highroads radiated and from which distances were reckoned.

In Saxon times trade developed with the lands whence the Saxons came, and the Venerable Bede testifies to the international character the trade of London had assumed in the seventh century when he states that "London is the metropolis of the East Saxons, situated on the banks of the aforesaid river, and is the mart of many nations resorting to it by sea and land."

It was not until Elizabethan times, however, that London forged ahead of Antwerp, her greatest competitor.

You will remember that it was in Queen Elizabeth's reign particularly that England's Merchant Adventurers penetrated rich and fertile lands in various parts of the world and began that conquest of trade which laid the foundation of our commercial greatness. Tropical and other produce carried by British ships was poured into London, which soon became the greatest market of Europe.

England's overseas trade continued to develop during the next 150 to 200 years and it continued to be centred very largely in London, where the great Trading Companies, such as the East India, the Levant and the Hudson's Bay had their headquarters.

At the close of the 18th century vessels from overseas sailed in convoys, owing to the Napoleonic Wars, and, as they sailed practically at the same time after the harvesting of some particular product and when winds were favourable, the arrival of all these vessels at one time, plus the colliers and

other coasting vessels, caused great congestion on the river. (I may remind you that before the advent of railways all coal was carried by ship). Owing to the wharves and legal quays being blocked with merchandise it was impossible for ships to discharge their cargoes for months together. Thieves did a roaring trade; it is computed that there were no less than 11,000 of these river thieves about the period mentioned. Sir Joseph Broodbank, in his admirable book on the history of the Port of London, points out that so many and various were these gangs that they were classified. There were "River Pirates," "Night Plunderers," "Scuffle Hunters," "Light Horsemen," "Heavy Horsemen," and "Mud Larks." Several estimates were made as to the amount of the losses, but no satisfactory data existed for making the calculation. The estimates placed the aggregate losses from plunder to merchant and the public revenue at from £250,000 to £800,000 per annum. Whatever the figure, the losses suffered by the merchants and the Crown in revenue were so serious that the idea was conceived of constructing a protected water area in which vessels could lie and discharge their cargo in safety. Such were the conditions which existed until about the year 1800.

The first enclosed wet dock in London was constructed about the year 1700 (actually begun about 1696) and was known as the Howland Great Wet Dock. It was what we should now consider a very primitive affair. It had a water area of ten acres, a single pair of gates only, and no warehouses or storage accommodation. It was not until the end of the 18th or the dawn of the 19th century that, through sheer necessity, the building of docks in London was undertaken on a large scale.

The first dock of importance was the West India Dock—promoted by the West India Merchants and opened in 1802 by Wm. Pitt, then Prime Minister, and to-day this is the chief dock for the storage of sugar and rum. Other groups of merchants having interests in the East and elsewhere soon had their own particular docks (London Dock for wine, brandy, tobacco; the East India Dock for general merchandise from India, China, etc.).

For about 100 years after the building of the West India Dock the business of the port continued to increase but owing to financial difficulties, principally brought about by severe competition between the various dock companies and the public wharfingers, the dock companies were unable to carry out the extensions and improvements which the ever-increasing trade of the port demanded.

As a result of the outcry by the traders and the public the Government appointed a Royal Commission to inquire into the whole question. The final result was the creation of the Port of London Authority in 1909.

There were thus transferred to the Authority by Act of Parliament the docks of the London and India, Surrey Commercial, and Millwall Companies, and the control of the tidal portion of the river Thames, a distance of 69 miles, formerly under the administration of the Thames Conservancy. The river above

Teddington is still controlled by that body. The Act also transferred to the Authority the powers of the Watermen's Company, so far as it related to the registration of craft and of lightermen and watermen. The purchase price of all these undertakings was fixed by the Act at nearly £23,000,000.

The Port of London Authority to-day consists of 29 members, 18 of whom are elected by payers of dues and charges and 10 are appointed by public and Government departments, such as the Ministry of Transport, Corporation of London, London County Council, etc. The present Chairman was elected by the other 28 members from outside their number.

In short, the Port is controlled by those whose interests are closely allied to it, and, as our charges are occasionally criticised, it will be some satisfaction to those critics to know that those who are responsible for the rates and charges have to pay the same themselves. It will, therefore, be appreciated that the interests of the members of the Authority and their critics are identical.

The water area of the docks alone is 720 acres. There are 36½ miles of quays, whilst the entire estate is 3,234 acres.

About 25 million tons of merchandise enter the Port of London yearly, about 14 million tons being from overseas.

The important position which the Port of London occupies in relation to overseas trade is indicated by the fact that in 1926 (the latest year for which complete Board of Trade figures are available), the value of London's imports and exports, excluding coastwise, amounted to nearly £702,000,000, exceeding those of Liverpool, the next most important port, by more than £193,000,000, and being nearly twice the values of the combined imports and exports of Hull, Manchester, Southampton and Glasgow. Put in another way, one-third of the total import and export trade of the United Kingdom is dealt with through the port of London. Within the last few days the Board of Trade have issued preliminary figures which show that in 1927 London's import and export trade, excluding coastwise, amounted to over £706,000,000, exceeding Liverpool by £225,000,000.

The enormous growth of London's trade can be judged from the fact that in 1700 the value of the imports and exports was £10,264,000. £10,000,000 worth of merchandise in those days was considered a high figure, and it undoubtedly was so, as such commodities as sugar, rum, wines, spirits and other valuable articles were the principal imports.

Within the last few years there has been a decided tendency for additional industries, such as motor car manufacturing, engineering and paper making, to be established in or near to London, and for important businesses to be centralised here. This is doubtless due to the development of electricity and to the shipping, trading and other facilities in which London is pre-eminent.

As a further indication of London's commercial greatness, one has only to turn to the financial transactions of the city. In 1927, out of a total sum of

£41,550,541,000, which passed through the Bankers' Clearing House, £38,577,714,000 were dealt with by London.

The net register tonnage of vessels entering and leaving the port has increased from 650,000 in 1700 to the huge figure of over 52½ million tons in 1927, which is over 14 million tons more than in the first year the Authority took office and constitutes a record in the history of the port.

I submit that these shipping and trade figures prove that the Port Authority's bold policy of extensions and improvements, involving an expenditure of £15,000,000, has been amply justified. The outlay of additional capital, however, necessitates increased business and it rests with the Traders of London to help the Port Authority by using the facilities provided. By so doing they must inevitably benefit themselves, since the larger the volume of tonnage handled by the Authority, the wider the area over which the overhead charges can be spread.

A comparison of the shipping figures for the out-ports shows that in 1913 London's figures exceeded those of Liverpool, the next leading port, by 9,000,000, and in 1927 by over 20,500,000 net register tons.

Over 60% of the shipping entering the port discharges in the docks, the remainder at wharves, at manufacturers' premises or at moorings in the river. A large part of the cargo, not intended for immediate consumption, goes into the Authority's warehouses on the docks and quays. This warehousing business is of great importance, comprising, as it does, every class of merchandise entering the port. The principal are grain, timber, wines and spirits, wool, frozen meat, sugar, tea and tobacco.

About 2½ million tons of imported goods yearly are passed over the Authority's quays, while the normal stock of goods stored with the Authority is about 600,000 tons, a striking figure when it is remembered that the modern tendency is for goods to go directly into consumption, and that the need of holding large stocks is far less pronounced than it used to be. The stocks held by the Authority in 1921 however totalled over 1,000,000 tons.

It is often supposed by strangers who visit the docks that the produce stored in the warehouses is the property of the Authority. This is not the case. The Authority import absolutely nothing. They are, as a body, neither growers, producers nor importers of produce. They are custodians only.

In addition to the ordinary labourage connected with the handling of goods ex ship the Authority have a staff of experts who perform such operations as the owners of the goods may direct. They house the produce discharged from the vessels; report upon its weight, quality and condition to the merchants interested, sort it to quality and to marks; open packages containing such goods as are sold by inspection of the whole package, and furnish samples which represent the exact condition of the produce. These samples are sent for exhibition to the London sale rooms where they are inspected by intending buyers.

The Authority also carry on a large business in the conveyance and shipment of export goods, the normal quantity passed over the quays annually being about 700,000 tons.

However, it is in connection with some of the interesting businesses warehoused and dealt with by the Authority that I wish particularly to speak this evening.

We will commence our hasty tour of inspection at the Authority's Uptown Warehouses.

City Warehouses.

One of the Port Authority's city warehouses is known as Commercial Road Warehouse. It was specially designed for the accommodation of the traffic to and from the Tilbury Dock, being directly connected by rail with that dock. The total floor area of the warehouse is approximately eight acres.

In addition to being used for the accommodation of traffic landed at the Tilbury Dock, Commercial Road Warehouse is used for the storage of Indian, Ceylon and China teas.

Cutler Street warehouse is another of the Authority's City premises. It covers an area of five acres, holds 20,000 tons of goods, and has an average stock of merchandise worth about £5,000,000. Thousands of tons of tea are stored there besides carpets from Turkey, Persia and China, and cotton carpets from Bengal and Northern India. Porcelain from China and Japan is also stored there.

In this warehouse are to be found large quantities of Oriental curios, including gods from the four corners of the earth; in fact, more gods are stored there than it is generally supposed are worshipped! In addition, there are carved ivory figures, bronzes, lacquer cabinets, silk and satin screens beautifully embroidered, vases and bowls of beaten brass, Egyptian and Persian coffee pots and holders, Japanese pictures, and ancient manuscripts from Persia and Mexico; also raw and waste silk and silk and cotton piece goods from China, Japan and Bengal, the silk and cotton piece goods alone being equal to 5¼ million yards, valued at over £650,000.

The warehouse is also the centre of the ostrich feather trade. About £3,000,000 worth of these feathers, principally used for trimming ladies' hats, formerly passed through this warehouse every year and, although we still have large stocks on hand, this great industry, which furnished employment for a great number of people and, incidentally, brought revenue to the coffers of the Authority in warehousing charges, etc., is now practically dead.

Ostrich farming in South Africa was also a flourishing business, but as there is now little demand for the feathers, the birds are being slaughtered wholesale. All this has been brought about by the change in the fashion of ladies' hats, due to the fact that the ladies now shingle and permanently wave their hair. In fact, a whole industry overwhelmed by a permanent wave!

While the ostrich feather industry has declined, the Authority are warehousing considerably more silk and silk stockings. Thus, while fashion has robbed us of the ostrich feathers which formerly adorned ladies' hats, it has given us a great display of silk stockings! This display is pardonable even when the stockings leave our warehouse. When ostrich feathers were worn the full value was displayed. Therefore, one cannot blame a young lady who pays, say, 10s. for a pair of silk stockings, wanting to show at least 8s. 6d. worth!

There are nearly three acres of floor space available for showing and storing carpets at Cutler Street, the present stock being about 1,350 tons, representing 800,000 square yards of an approximate value of £2,000,000.

It is at this warehouse, also, one may see all the great drug staples of the world, such as aloes wrapped up in monkey skins (no doubt there is a scarcity of paper and other suitable wrapping in Africa, where aloes principally come from, while monkeys are plentiful), gamboge, ipecacuanha, sarsaparilla, Turkey rhubarb and gum benjamin.

The extensive warehouses at Cutler Street and Commercial Road are also used by the Port Authority for the storage of tea, of which about 50,000 tons (including that dealt with by tenants at St. Katharine Dock), are housed and delivered annually.

In 1927 London received 496,000,000, lbs. of tea, more than 90% of the total importation for the United Kingdom.

To-day the stock of tea in the port is about 186 million lbs., valued, with Customs duty, at over £16,000,000.

This stock is equal to nearly 5¼ months' supply for the United Kingdom at the present rate of consumption, viz., 9 lbs. per head per annum. The rate of consumption in the U.S.A. is less than 1 lb. per head per annum, and on the Continent less than ½ lb. Thus there would appear to be a great future for tea, especially in the U.S.A., where legislation prohibits the importation or manufacture of alcoholic beverages.

St. Katharine Dock.

The St. Katharine Dock has a water area of only 10 acres and is the smallest of the docks in London, being used by the smaller class of vessels, i.e., vessels up to 1,000 tons gross register. It was commenced in 1827 and publicly opened in 1828.

The dock, although small, serves a useful purpose, as it is surrounded by fine ranges of warehouses which contain tea, indigo, hops, dried fruit, canned goods, wool, shells, etc.

Four large and well-lighted rooms are devoted to the use of shell importers. Here large supplies of valuable shells, brought into the Thames from all parts of the world, are opened by the Authority's officers, weighed, sorted and lotted for the public sales, which are held six times in every year.

Tortoiseshell is also warehoused at this dock. At the sales of tortoiseshell as many as five hundred lots are sometimes shown, arranged in three tiers round the windows.

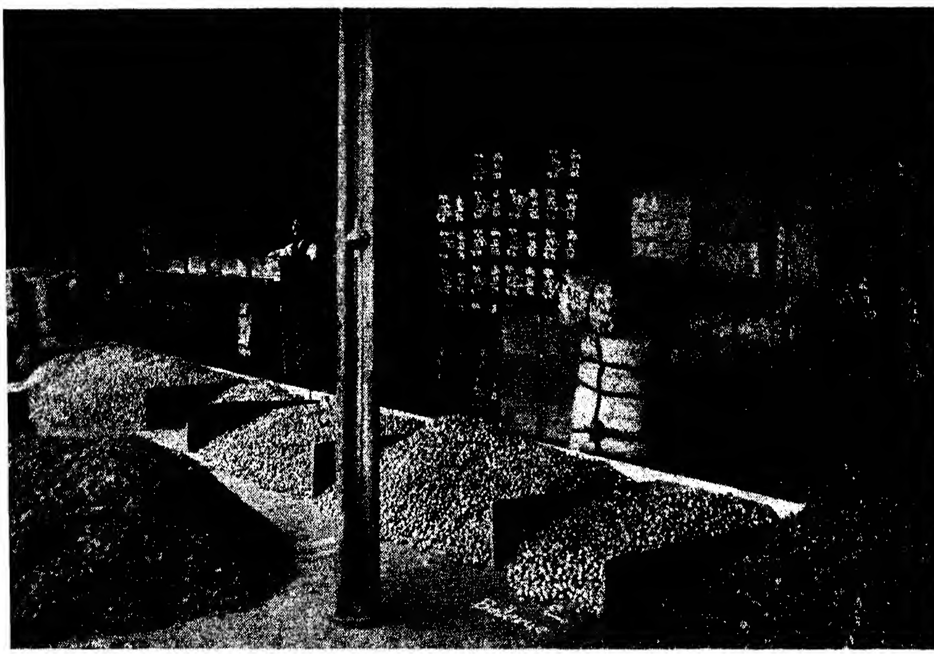
London Dock.

The London Dock, which was opened in 1805, is adjacent to the St. Katharine Dock and has a water area of 35 acres. This dock also accommodates the smaller class of vessels, but the warehouses, which are very substantially built, house some of the most valuable articles entering the port of London. There is accommodation in the warehouses for about 220,000 tons of goods. Special premises are set apart for warehousing, working and showing wool, tallow, wine, brandy, sugar, rubber, gutta percha, balata, dried and green fruits, ivory, spices, bark, gums, metals, drugs, dates, pepper, rice, coffee, cocoa, isinglass, iodine, quicksilver and many other valuable goods.

A warehouse is provided at London Dock for the storage of ivory, the bulk of which comes from Africa and from India, Ceylon and other Asiatic countries. A small quantity, brittle in quality, comes from Siberia, under the name of fossil ivory, being tusks of extinct mammoths which have long been buried in the frozen soil of that region. The ivory of Africa is shipped from almost every port in that Continent, and is superior in density and whiteness to any other description. It may here be said that many, perhaps most, of the tusks of elephants shown are not from recently killed beasts, but are the old treasures of African chiefs reluctantly surrendered, and stored, may be for centuries, in remote African villages.

When received at the docks the ivory is weighed by the Authority's officers, examined, classified, and laid out for the merchants' inspection. Special attention has to be directed to the detection of stones and metal, which are sometimes inserted by the natives in the hollow at the root of the tusk in order to increase the weight. The tusks are sometimes 9 feet in length, weighing 140 to 150 lbs. each, and the value is now about fifteen shillings per lb. The annual importation of ivory into London is about 200 tons, representing the ivory of about 2,500 elephants. Accommodation is also available for cinnamon, nutmegs, mace, pepper and other spices. Every package of cinnamon has to be opened by our men and repacked in order to discover whether the material inside is of equal quality to that which is visible to the naked eye. Sometimes they discover pieces of wood inside the bales. Cinnamon is the inner bark of a tree and is folded into quills. It is used for cookery and in chocolate, and is a great specific for influenza. Some years ago, during an outbreak of influenza, a deputation of medical men visited the docks to inquire whether any of the men working on the cinnamon floor suffered from influenza, and it was discovered that none of them had it, or had ever had it.

One of the floors of the spice warehouse at the London Dock is used for sorting nutmegs, which are very liable to the attack of a beetle and are often coated with lime before shipment as a protection against this insect, which bores holes and spoils the nutmegs. Before the nutmegs are sold our men have to look at every one and separate the holey ones from the sound. The holey ones are ground up and sold as mixed spice and the very lowest quality used for giving a flavour to cattle food. Nutmegs come from Singapore, Penang, Madagascar and the West Indies, and are the kernels of a fruit of which mace constitutes the husk.



Sorting Nutmegs—London Dock.

Another commodity warehoused at London Dock is rubber. In 1927, 371,000 tons of rubber were exported from the plantations in the Malay Straits and other producing countries; of this London received one-third.

The greatest consumer of rubber is the U.S.A., which obtains supplies not only from London but by direct shipment from the producing countries. They take 75% of the world's production, but this will be appreciated when it is remembered that out of a world total of 30,000,000 motor cars the United States of America owns 25,000,000, or one car to every five persons, compared with one car to every thirty-six persons in the United Kingdom. There are three floors at London Dock, each 250 feet in length, reserved for the "working" of rubber.

Colonial Wool on show, London Dock.

The total number of sheep in the world is estimated at 604 millions, producing about 9 million bales, or over 1¼ million tons of wool yearly. About 45% is produced in the British Empire. The United Kingdom takes about one-fourth for manufacturing purposes, and of this nearly one-half comes to London.

Put in another way, London deals with over 55 million sheep fleeces yearly, and a large proportion is warehoused at London Dock, being in point of both tonnage and value one of the most important articles dealt with there.

The Port Authority make a special study of the handling of wool and devote ten acres of well-lighted top floors for showing purposes. 40,000 bales can be shown at one time. A further 20,000 bales can be shown at privately-owned warehouses in the port.

Buyers from all parts of the world attend the wool sales in London and the keenest bidding is experienced. It is calculated that on an average run of years better prices are obtained in London than at any other market in the world.

It is interesting to note that in the reign of Edward I wool was England's greatest export. It was shipped to Flanders for manufacture into clothing, but about the year 1336 Edward III encouraged the Flemish weavers to settle in England. This was the beginning of the great industry of cloth manufacturing in this country and to-day wool is one of England's principal imports. To show their appreciation of the wool industry—but more probably the excellent revenue they were able to derive in taxes from it—the early English kings placed their Chief Counsellor, the Lord Chancellor, on a sack of wool, and this ancient custom of the Lord Chancellor sitting on the "Woolsack" whilst in the House of Lords obtains to-day.

It has been said that London Dock is the real port of London, as it is here that wine, particularly from Oporto, is stored! The famous wine vaults in London Dock were built 120 years ago, when a man's popularity was often judged by the number of bottles of port he could consume at one sitting. The length of the rails in the gangways in the vaults is 28 miles, and nearly 3 million gallons of wine can be stored at one time. In addition, there are 5¼ acres of brandy vaults capable of storing at one time 120,000 quarter casks. The temperature in the wine vaults is about 60° Fahrenheit, and varies very little on the coldest day of winter or the hottest day in summer.

On the ceiling of the wine vaults may be observed an extraordinary fungus which is entirely absent in the brandy and rum vaults, whose ceilings are as clean as those of a cathedral crypt. If it is true that port wine kept in cask is not so gouty as that kept in bottle the escape of this fungus through the wood no doubt accounts for it, but I cannot pretend to enlighten you on this point.

In the brandy vaults we hold some brandy which has been there since 1870.

SURREY COMMERCIAL DOCKS.

The Surrey Commercial Docks are situated on the south side of the Thames and, including the ponds set apart for the floating of timber, have a total water area of 147 acres, with quayage of over 5¾ miles. They are the finest wood depots in the world and are chiefly used by the Baltic and Canadian trades. Although cheese, bacon and grain are housed here, it is better known as a timber dock. Practically all the soft wood coming to London—timber such as pitch pine, deals, and other woods used for building purposes—is stored either at these docks or at Millwall Docks. There are 112 acres of covered and uncovered storage space for timber and timber ponds 36 acres in extent. When a cargo of timber is landed on the quays, experienced men handle it and pile it away to various marks, qualities and sizes. The work of piling is one demanding skill, which is only acquired after long practice.

The annual import of timber into London is nearly two million tons and the stock in the Authority's docks is about 350,000 tons.

WEST INDIA DOCK.

Hard wood, which includes the furniture timbers such as mahogany, teak, oak, walnut, ebony, satinwood, and other expensive kinds, is stored chiefly at the West India Dock, but large stocks are also accommodated at the Surrey Commercial Docks.

The West India Dock is the chief depot for rum in the United Kingdom, the present stock being about 22,000 puncheons, equal to nearly 50 million half pints of proof spirit—enough to intoxicate the whole population of the United Kingdom if taken at one sitting. The value with duty is about £13,000,000.

The West India Dock is also the principal warehousing centre for sugar, of which London imported 667,000 tons last year.

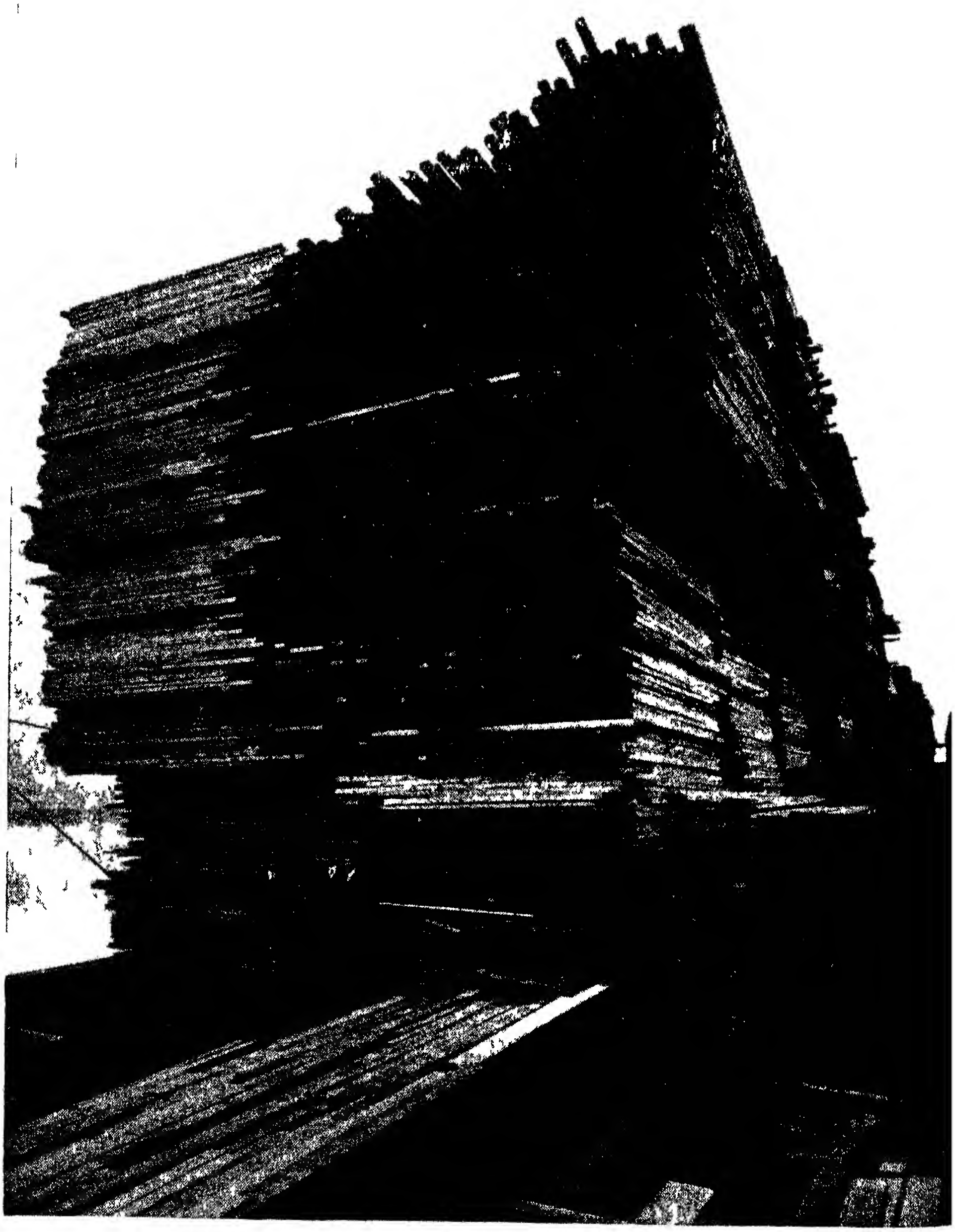
MILLWALL DOCK.

The Millwall Dock has a total area of 231 acres, of which over 35½ acres are water. Grain handling is a special feature of the Millwall Dock, and it is estimated that two-fifths of the about 3 million tons of grain and feeding stuffs coming into the Port of London is handled at this dock, most of the grain being discharged by pneumatic elevators.

The Central Granary, Millwall Dock, will hold about 24,000 tons of grain—sufficient to make 26,400,000 half quartern loaves, a little more than a week's need of the London district (viz., 24,375,000 loaves).

The grain is discharged from the steamer to the warehouse by means of pneumatic tubes by which it is sucked from the hold of the vessel and conveyed by bands into the warehouse.

The grain-discharging appliances at the Millwall Dock are capable of dealing with 500 tons of bulk grain per hour.



Timber, Surrey Commercial Dock.

At the West India and Millwall Docks, which are situated about two miles from the city, the Authority have decided upon a scheme of development in order to render these deep-water docks and quays available to larger ships. The West India and Millwall Docks are therefore being remodelled and unified by making three new ship passages connecting the Millwall Dock and South West India Dock, and West India Dock, and by making a new river entrance at Blackwall 584 feet long, 80 feet wide with 35 feet in depth below Trinity High Water, which will serve the remodelled docks.

The new ship passages with a depth of 29 feet of water have been completed and the water area of this system is now 127 acres with over 5 miles of deep-water quays, all of which will be available through the new entrance to vessels up to 15,000 tons. To bring the equipment and quays into line with the modernised docks a series of single and double storey sheds, with new quay surfaces, rail and crane tracks, and roads are to be built. The cost of the whole scheme will be about £1,500,000.

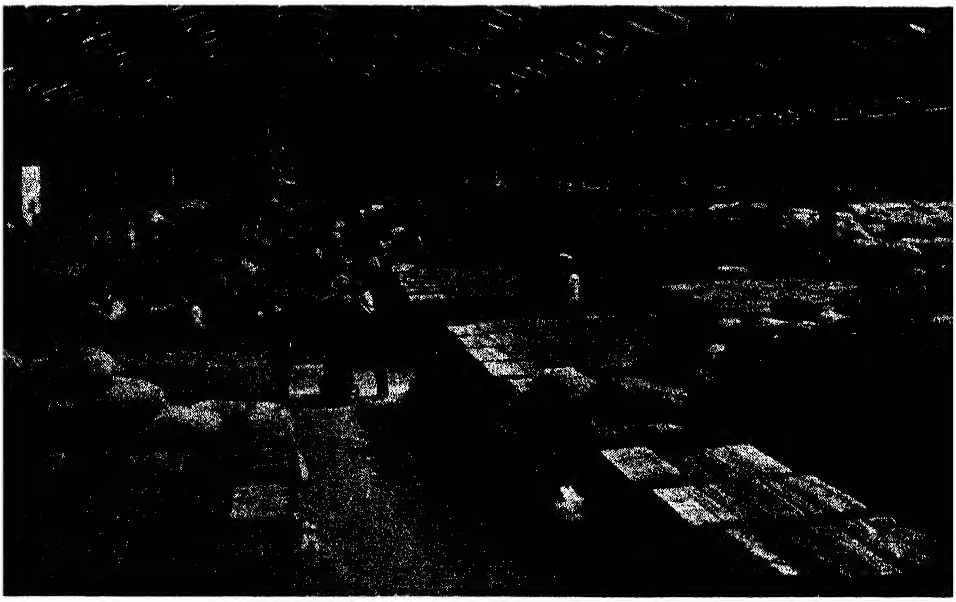
ROYAL VICTORIA AND ALBERT AND KING GEORGE V DOCKS.

We now come to the largest dock system in London and, incidentally, the largest sheet of dock water in the world, namely, the Royal Victoria and Albert and King George V Docks. These docks, which have a water area of 246 acres, form one continuous sheet of water, the Royal Victoria and Royal Albert Docks alone being three miles long. Ten miles of shipping can be accommodated in these docks.

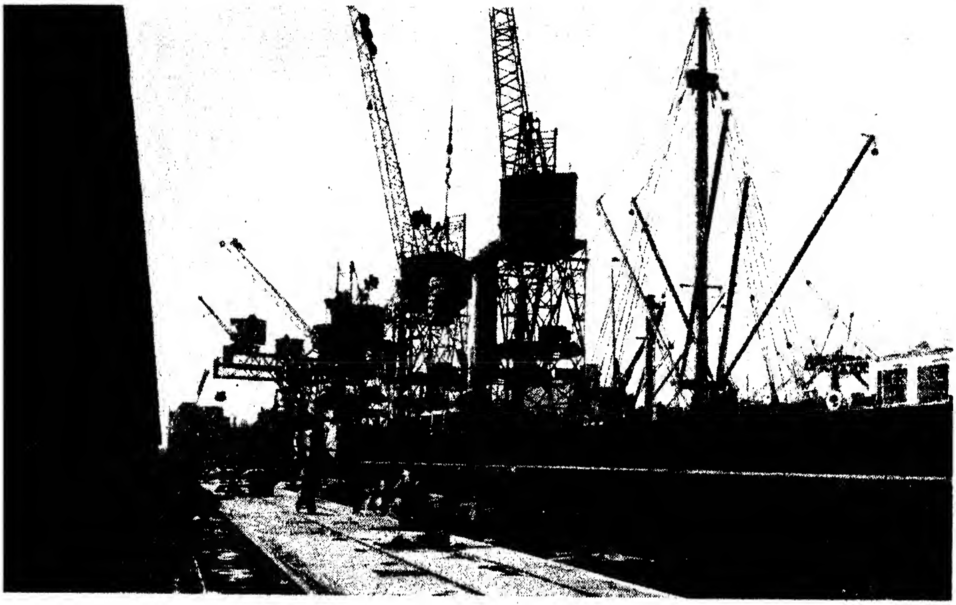
The docks of the Authority, with the exception of the London and St. Katharine Docks and the Surrey Commercial Docks, are in direct communication with the railway systems of the London, Midland and Scottish, London and North Eastern and Great Western. The Port Authority's railway system consists of about 170 miles of rails and the tonnage dealt with exceeds 1½ million tons annually.

The King George V Dock, which was opened by his Majesty in 1921, has a water area of 64 acres and cost £4,500,000. Its equipment includes over 100 cranes, the lifting capacity of which ranges from 15 cwt. to 25 tons. The largest crane in London is the "London Mammoth," capable of lifting up to 150 tons. London's largest liner, the s.s. *Minnewaska*, of the Atlantic Transport Line, berths in the King George V Dock and runs between London and New York.

There are to-day over 45,000 tons of tobacco in the port, the value of which, including duty, is about £60,000,000. This tobacco is equal to about 1,600 million ounces, or sufficient to supply the *male* population of Great Britain (21 million) with one and a half ounces a week for a year. The total yearly import of tobacco into the United Kingdom is about 95,000 tons, 16% of which is produced in the British Empire. A few years ago the British Empire only produced 4 to 5%.

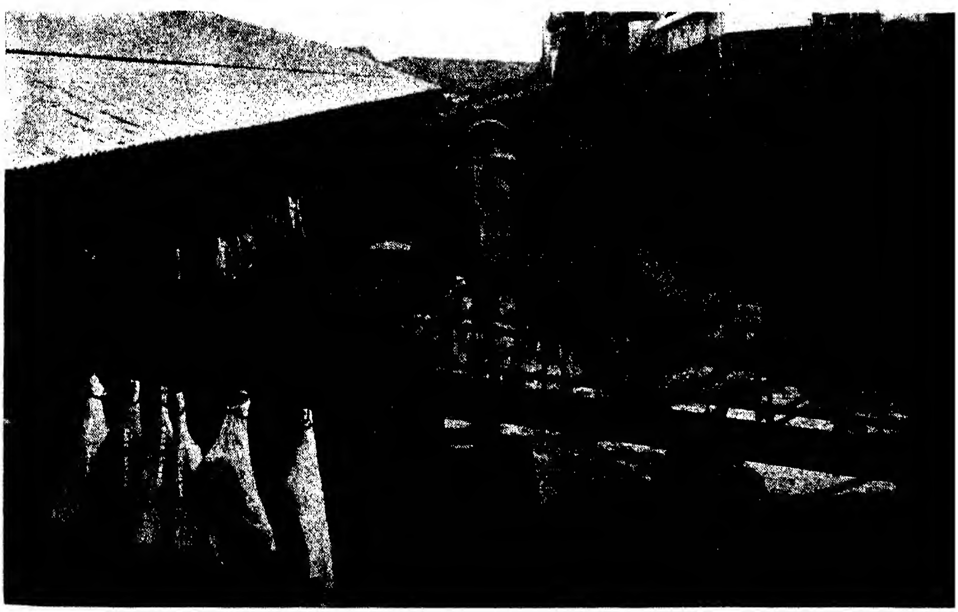


Export Shed, Royal Albert Dock.



King George V Dock, showing Cranes.

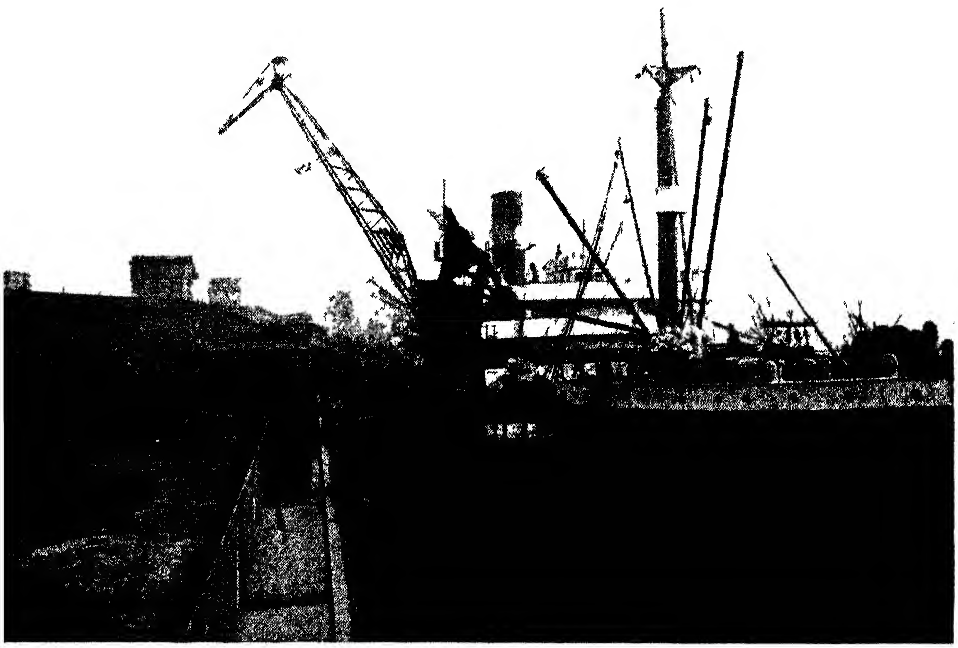
Tobacco Warehouse, King George V Dock, showing Underhung Crane.



Discharging Chilled Beef, No. 35 Shed, Royal Albert Dock.

The chief frozen meat stores in the United Kingdom are situated in the Royal Victoria and Albert Docks system, accommodation being available for one million carcasses of sheep. New berths for the discharge of frozen and chilled meat have been constructed recently. Each berth is equipped with all necessary handling appliances, sheds, roadways and railways.

At the cold sorting floor, Royal Albert Dock, meat is taken out of the ship's hold by means of cranes and put on to conveyors, or endless belts, sorted in a refrigerated warehouse and passed to the cold storage chambers proper by another set of endless belts or delivered to insulated vans for Smithfield Market or insulated railway wagons for the provinces. In short, the meat is subjected to the minimum amount of handling and scarcely comes into contact with the atmosphere outside.



Cold Sorting Warehouse, Royal Albert Dock.

The capacity of the Authority's cold stores in these docks and elsewhere is now equal to 1,150,000 carcasses of sheep, or 28,750 tons, while cold storage equal to a further 2½ million carcasses is available elsewhere in the port. During the war these great stores were a national asset, and although the public were on strict rations this accommodation plus the accommodation at other ports was at times insufficient to meet the demands of the Food Controller.

The consumption of meat, i.e., beef, mutton and lamb, in the United Kingdom is about 2 million tons yearly, or 2 lbs. per head per week of the population.

Roughly, half is imported and half home-grown, the actual percentages being 45% imported and 55% home produced. Before the war only about one-third was imported; last year the total importation was 950,000 tons. London's share was 687,500 tons or 70%, the equivalent of over 27½ million carcasses of sheep. From 80 to 85% of the meat marketed in London comes from overseas, so that only one Londoner out of seven can now reckon upon having British-fed meat to eat.

In 1927, 562,867 tons of provisions were inported into London. From New Zealand alone London imports over 60,000 tons of butter and 75,000 tons of cheese yearly.

TILBURY DOCK.

The Tilbury Dock, which has a water area of 90 acres, shares with the King George V Dock the distinction of being the deepest dock in London, being 38 feet to 42 feet in depth. The "crack" liners of the Orient Company, the P. & O., and other important lines have their homes in this dock.

Owing to the increasing size of the ships using the Port of London, it has been decided to construct a new dry dock on the south side of Tilbury Dock. Its dimensions are 750 feet in length (capable of extension to 1,000 feet at any future time when required), 110 feet in width and a depth of 37½ feet on the blocks, and it is expected that the work will be completed this year.

The Authority are also constructing a new entrance lock at Tilbury Dock, 1,000 feet in length, 110 feet in width and 45½ feet deep at Trinity High Water. The entrance lock is expected to be completed next year and will be able to accommodate the largest ship afloat, viz., the s.s. *Majestic*. The cost of the new entrance lock and dry dock will amount to £2,400,000.

Near the Tilbury Dock the Authority have constructed a deep water jetty for the accommodation of vessels discharging part cargoes. The jetty is 1,000 feet long and equipped with the most modern appliances. It is directly connected with the London, Midland and Scottish Railway, and goods can be temporarily accommodated in the two-storey warehouses on the jetty itself.

One of the most interesting schemes, however, to those who travel overseas is the new passenger landing stage at Tilbury which the Authority is constructing in conjunction with the London, Midland and Scottish Railway Co.

Hitherto the passenger facilities in the port have been inadequate, as those who embark and disembark can testify.

In their programme of developments the Authority up to now has been compelled to give preference to the more pressing needs of commerce, but attention is now being paid to the needs of the passenger, and it is anticipated that, given adequate and comfortable facilities, the passenger traffic of the port will greatly develop.

The landing stage will be 1,142 feet long with a depth of water alongside of 35 feet below low water at ordinary spring tides, so that some of the largest liners

may berth there at all states of the tide. It will be a floating structure adjacent to the new railway station which is being built by the railway company. An important feature will be a commodious Customs and Baggage Hall which the Authority are constructing.

Every possible convenience will be afforded for the comfort and despatch of passengers.

A service of express trains to and from the Metropolis will be provided by the railway company, and it is expected that the journey will occupy about forty minutes.

TILBURY HOTEL.

There are several hotels in the docks belonging to the Authority. The principal is the Tilbury, and I take this opportunity of advertising it. Anyone interested in shipping could spend an enjoyable week-end at this hotel watching the ceaseless shipping traffic passing up and down.

DISTRIBUTING FACILITIES.

A glance at the map of the country will reveal the network of railways connecting the port of London with the provincial centres. London's distributing facilities and transport connections are unrivalled. All trunk railway lines, the main road services and coasting and continental shipping lines, radiate from London.

AMBULANCES.

The Authority have an excellent and well-trained staff of men, and provide all the equipment for dealing with accidents in the docks. They have a number of motor ambulance wagons, and call boxes are placed in conspicuous places about the docks, so that in the event of an accident there may be as little delay as possible in rendering assistance.

POPLAR HOSPITAL FOR ACCIDENTS.

Opposite the entrance to the East India Dock is the Poplar Hospital for Accidents. This is the principal hospital used by dock labourers. It was founded by the East India Dock Company seventy years ago, and is mainly supported by the shipowners and merchants of the port, the Authority itself and the individual members contributing generously to its maintenance. I have the honour of being the Acting Chairman.

I have mentioned the Poplar Hospital to remind you that the operations of a great port invariably bring in their train accidents and sickness to the men who do the work, and that the former dock directors and the present Authority have not neglected their duty in helping those who require it. Indeed, at this beautiful hospital (for it is beautiful) patients come in not only from the docks but also from all the ship-building and ship-repairing yards

and from the factories in the neighbourhood. One thousand accidents and medical cases are treated each week.

HEAD OFFICE.

In an undertaking of the magnitude of the Port of London Authority it is necessary to have central offices where the headquarters staff can be housed and work in touch with each other. Prior to 1922 half the staff were scattered about the city in rented offices. On the 17th October, in that year, the Authority's new head office in Trinity Square was opened by the then Prime Minister, Mr. Lloyd George. The building is considered to be worthy of the greatest port in the world.

Although I have only dealt very briefly with the ramifications of the Authority's dock business, I hope I have said sufficient to show you the magnitude of the undertaking and the greatness of London's trade, and I venture to say that great as the trade of the Port of London is to-day the zenith has not yet been reached.

The sole aim of the Port Authority is to maintain London as the premier port and market of the world. I cannot help feeling that had the Authority not been created this position would not have been maintained and that possibly it would have been lost to a continental rival which would have been not only a commercial, but a national, disaster.

The following lines, written by the poet Cowper in the 18th century, are true to a far greater extent to-day :—

" Where has commerce such a mart,
So rich, so throng'd, so drain'd, and so supplied
As London—opulent, enlarg'd and still
Increasing London ? Babylon of old
No more the glory of the earth than she
A more accomplished world's chief glory now ! "

DISCUSSION.

SIR CYRIL KIRKPATRICK, M.Inst.C.E., desired to say how much he had enjoyed the author's description of the Port and its activities. It was not altogether new to him ; he had seen some of the actual places himself. In listening to the lecture he had been reminded of his own happy experience of the Port Authority during the twelve years for which he was Chief Engineer. Port Authorities in general rather looked at their engineers askance because they spent money, but he himself was of opinion that ships were going to get bigger and bigger, and Port Authorities would have to spend more and more money if they were not to be left behind. The Port of London Authority had taken the bull by the horns, and was going to reap the benefit. He hoped it would prosper in the future as in the past.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., said that he had listened to the lecture with very much interest, and he wanted, on behalf of the Council of the Royal Society of Arts, to thank the author of the paper. He had, however, a bone to pick with him, for while Mr. Estill had mentioned that wonderful hospital of his,

the Poplar Hospital for Accidents, he had quite forgotten that still more wonderful hospital in the Royal Albert Docks—the Seamen's Hospital. He had also a bone to pick with the Chairman—a delicate thing to do—for he had insulted the "brothers of Trinity House"! However, the Chairman was an old friend and colleague, and he forgave him, but he would remind him that all these wonderful docks that had been built would not have had a ship in them had it not been that the Elder Brethren had lit the estuary of the Thames. A great deal had been said about the organisation of the board of management of the Port Authority. He agreed with every word the Chairman had said. He himself had sat on that board for 15 years, and for eight years he was chairman of one of its chief committees. It was a very wonderful body of men, all engaged in the various activities which had been so eloquently described that evening. All of them had different interests to protect, and therefore were somewhat in opposition to one another, though they all worked together for the good of the Port of London. A better organisation he had never known. He was talking to a former chairman the other day, and asked him whether he would be right in saying that the average attendance at the meetings which used to be held once a week was between 18 and 22 out of a total, then, of 26 members, and the reply he got was that he would be right in saying it was 22. Not one of the members got a single penny for attendance (though, incidentally, there was a good lunch). Something had been said about the organisation in its beginnings, and perhaps he might be permitted to say that the organization emanated from the brain of two men, namely, Mr. Lloyd George, then President of the Board of Trade, and Lord Devonport, then Financial Secretary to the Board. Those two men must have the credit of bringing the organization into being. Both of them were men of vision and knowledge, and the work had been ably carried on by the Chairman, whose portrait they had just seen on the screen. With regard to the dredging of the river, the slogan for all dock authorities was, "Dredge rivers and entrances and build docks, and the ships will come." If the entrances were not dredged and the docks not built, the ships could not come. The speaker suggested that a glance at the Upper Pool from London Bridge would surprise many people. Above the Tower Bridge there were ships of six or seven thousand tons. If such a thing had been prophesied thirty or forty years ago the prophet would have been laughed at. It was the dredging of the river which had brought it about. That was vision again on the part of the Port Authority which spent large sums of money on the project. Mention was made of the width of dock entances. There had always been trouble with dock authorities as to how wide an entrance was to be. In the case of King George's Dock, some wanted the entrance built 85ft. wide, some 90ft., some 110ft., and a compromise was reached at 100ft. If it had not been for that compromise on a considerable width these big ships mentioned by the lecturer would not be entering the dock to-day. He had been interested in the figures relating to the imports of mutton. He used to say that if the frozen sheep that were passed through London in one year were put in single line ahead (head to tail) they would reach from here to New Zealand, with two or three thousand miles to spare. He again thanked the lecturer for a most instructive and stimulating description.

Mr. F. W. Davis said that the lecturer had fully explained the necessity for these improvements and increased facilities. It had been the speaker's privilege to have been connected with these works in an engineering capacity since their inception at the West India and Milwall Docks two and a half years ago. The works had been carried on by day and night and had afforded much-needed employment to a large number of men. The actual number of men employed on the construction had reached nearly three thousand, and of these 60 per cent. were ex-service men.

All the materials, except timber, were of British origin or production, and, where possible, preference had been given to colonial over foreign timber. Good progress had been made by the contractors entrusted with the work, and they had tackled the heaviest tasks with great courage and enterprise. It was practically certain now that the whole of these extension works would be completed within the coming year. There were several miles of quays, now practically idle, which would be made available for new business, and he could visualize Mr. Estill very shortly thirsting for the great post-war expansion in trade predicted in that room ten years ago by a former lecturer on the Port of London.

The Chairman, in closing the meeting, said that he was sorry Sir Arthur Clarke had gone, because Sir Arthur had remarked that if it were not for the lighted estuary there would be no docks, and he had wanted to remind him that if there had been no docks there would have been no destination to which to light the ships ! Sir Arthur was an old member of the Authority and had done a tremendous amount of work on its behalf. One speaker had remarked about larger ships. But he (the Chairman) believed that ships were now very nearly as large as it was possible to build them, and for the next stage in development he looked to aeroplanes. He rather thought it would be a mistake to look forward to very much larger steamers than there were at the present time. He called upon the audience to accord a hearty vote of thanks to Mr. Estill for a very interesting and instructive lecture.

The vote of thanks was carried unanimously.

Mr. Estill briefly expressed his acknowledgments.

The Secretary (Mr. G. K. Menzies), in proposing a very hearty vote of thanks to Mr. Thomas Wiles for his conduct of the Chair, drew attention to one feature of the historic room in which the Society assembled, as it showed the high respect the Society had always had for Father Thames. When the room was built, 150 years ago, the artist was instructed to decorate it with pictures symbolizing arts, manufactures, and commerce, and to symbolize commerce the artist took Father Thames. The speaker pointed to the painting of Father Thames on the east wall, as he was represented, with attendant nymphs, 150 years ago.

The vote of thanks to the Chairman was also carried unanimously.

Mr. Wiles, in acknowledgment, said that his duties had been easy and pleasant, and he only hoped that the lecture would serve to widen the interest in the river and Port of London.

The proceedings then terminated.

NOTES ON BOOKS.

Touch Typewriting for Teachers. By Maxwell Crooks. London : Sir Isaac Pitman and Sons, Ltd. 7*s*. 6*d*. net.

This book should be welcomed by all teachers of typewriting, both those who belong to what the writer calls the old-fashioned school of typewriting instructors, and those who have, or think they have, modern views on teaching the subject. It is highly probable that after reading the book many teachers will feel the need of some additional training on the lines indicated. It is refreshing to find a book on method, written specifically for commercial teachers. Typewriting texts have almost invariably been written for the use of students, and Mr. Crooks is to be thanked for his effort to assist the teacher directly and the student indirectly.

The book requires and deserves very careful reading, and it should give rise to much thought and some controversy. This is all to the good, since it is inadvisable that a text book should tend to stereotype teaching methods to such an extent that individuality in method is stifled.

For some years now, there has been a considerable change for the better in the teaching of typewriting. The change has been gradual—too gradual. Even to-day there are many teachers who have not been converted to "touch" methods, and there are others who, while professing conversion, have misunderstood what is implied in the method, and have not, in reality, been teaching it. To all such the book is commended with the hope that reading will be followed by a whole-hearted attempt to experiment along the lines suggested. When this is done there can hardly be any doubt as to the result.

The course as outlined appears to be well conceived and most chapters are full of "meat." The most praiseworthy features appear to be the writer's insistence upon a good mastery of the keyboard before students proceed to documentary work or to letter writing, and the separation of the subject, particularly in the early stages, from the teaching of office routine. At any time this last-named subject is of very questionable utility in schools, and in any case it should not be associated with the teaching of elementary typewriting. The slow rate of progress of many students is undoubtedly due to the non-observance of these principles enunciated by Mr. Crooks, coupled with a natural desire on the part of the student to get on to something more showy than mere keyboard drill.

The book should help teachers to realise that the touch method has not only been justified by experience, but that the days of the "sight" method are numbered.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 16.—PROFESSOR CHARLES R. DARLING, A.R.C.Sc.I., F.I.C. "The Domestic Smoke Problem—Practical Solution."

JANUARY 23.—SIR HENRY A. MIERS, F.R.S., "Museums and Education." THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

JANUARY 30.—GEORGE FLETCHER, "The Shannon Scheme and its Economic Consequences."

FEBRUARY 6.—SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture). SIR GEORGE SUTTON, BART., Chairman of Council, will preside.

FEBRUARY 13.—CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms and their Insect Visitors."

FEBRUARY 27.—A. F. SUTER, "Resins."

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., "Modern English Architecture."

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced :—

JAMES MORTON (of Morton Sundour Fabrics, Ltd.), " History of the Development of Fast-Dyeing and Dyes."

SIR GERALD BELLHOUSE, C.B.E., H.M. Chief Inspector of Factories, Home Office, " Safety in Factories."

J. F. CROWLEY, D.Sc., B.A., M.I.E.E., " Recent Developments in Vegetable Oil Extraction."

LADY INGLEFIELD, " Lace."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

FEBRUARY 8.—CAPTAIN E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., " The History of the Indian Marine." VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., will preside.

MARCH 8.—W. H. MORELAND, C.S.I., C.I.E., " The Report of the Royal Commission on Indian Agriculture from the Historical Standpoint."

APRIL 12.—A. T. COOPER, M.Inst.C.E., M.Cons.E., " Recent Electrical Developments in India."

MAY 10.—P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, " An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture).

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, " The Treatment of Coal." Three Lectures: January 21, 28 and February 4.

LECTURE I.—THE USE OF COAL IN ITS RAW STATE. Historical introduction—Production and distribution—Sampling and analysis—Efficiency of utilisation—Steam raising—Pulverised fuel—Furnaces and process work—Domestic heat production.

LECTURE II.—HIGH TEMPERATURE CARBONISATION PROCESSES AND COKE TREATMENT.—Gas manufacture—Purification, blending and sizing—Steaming—Oil injection—Total gasification.

LECTURE III.—LOW TEMPERATURE CARBONISATION—LIQUEFACTION OF COAL.—Low temperature carbonisation—Internal and External heating—Hydrogenation process—Synthetic processes—Combustion of oil.

SIR E. DENISON ROSS, C.I.E., Ph.D., " Nomadic Movements in Asia." Four Lectures: April 15, 22, 29, and May 6.

SHAW LECTURES.

Monday evenings, at 8 o'clock.

SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories 1898-1927, " Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4.

LECTURE I.—The " Looks " of the People.

LECTURE II.—Twenty-five Years' Experience of the Notification of Industrial Diseases.

LECTURE III.—Twenty Years' Experience of Compensation for Industrial Diseases.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 7..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Dr. Oscar Faber, "The Expansion and Contraction of Building Materials due to Temperature, Humidity, Stress and Plastic Yield." Award of Prizes and Studentships.

Chemical Industry, Society of, Burlington House W. 8 p.m. Mr. J. Ivon Graham, "The Action of Hydrogen upon Coal." (Joint Meeting with Fuel Section).

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. C. H. Karius, "The First Crossing from the Fly River to the Sepik, New Guinea."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m.

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin. Lecture II.—Mountains of Accumulation."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.0 p.m. Dr. W. Fell Dawson, "The Hebrew Calendar and Time Periods."

TUESDAY, JANUARY 8..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. T. P. M. Somers, "George the Fifth Bridge, Glasgow."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters, with particular reference to those for special purposes."
At the Royal Technical College, Glasgow. 7.30 p.m.

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. J. Calderwood, "The Diesel Engine for Passenger Ships and Fast Cargo Liners."

North East Coast Institution of Engineers and Shipbuilders, at Cleveland Institution, Middlesbrough. 7.30 p.m. Informal discussion on a Shipbuilding Subject, opened by Mr. W. T. Butterwick.

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. W. H. Fordham, "Geophysical Surveying."

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Prof. F. L. Hopwood, "Experiments with High Frequency Sound Waves."

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Mr. W. N. Edwards, "Microscopical Study of Fossil Plants."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. Alexander Wood, "Sound Waves and their Uses. How Sounds are Recorded and Reproduced." [Lecture VI).

Transport, Institute of, at the University, Bristol. 5.40 p.m. Mr. M. Arnet Robinson, "Coastal Liner Services."
At 200, Buchanan Street, Glasgow. 7.30 p.m. Mr. R. F. Smith, "Co-ordination."

WEDNESDAY, JANUARY 9..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. Archibald Page, "The Development of the Generation and Distribution of Electric Power in the British Isles."

Fuel, Institute of, at Burlington House, W. 6 p.m. Mr. H. A. S. Gothard, "The Application of Pulverised Fuel Firing for Lancashire Boilers."

Geological Society, Burlington House, W. 5.30 p.m. Prof. Dr. O. T. Jones, "The History of the Yellowstone Cañon, Yellowstone National Park, U.S.A."

Metals, Institute of, at Thomas' Café, High Street, Swansea. 7 p.m. Mr. G. E. K. Blythe, "Pulverised Coal in Metallurgy."

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Mr. Conrad Beck, "Lenses."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. Robert Campbell, "Mountains and their Origin." Lecture III. "Mountains of Accumulation." [Continued).

United Service Institution, Whitehall, S.W. 3 p.m. Mr. E. J. Foley, C.B. "The Board of Trade and the Fighting Services."

Wireless Technology, Institute of, at the Engineers' Club, Coventry Street, W. 7 p.m. Mr. J. Priechenfried, "Picture Transmission."

THURSDAY, JANUARY 10..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.0 p.m. Prof. B. Melvill-Jones, "The Performance of the Streamline Aeroplane."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Capt. J. M. Donaldson, and Capt. J. G. Hines, "A Study of the Future Development of Demand and the Economic Selection, Provision and Layout of Plant, as illustrated by Telephone Systems on the one hand and Power Systems on the other."
At University College, Dundee. 7.30 p.m. Mr. W. M. Mackay, "Static Rectifiers."

Historical Society, Royal, 22, Russell Square, W.C. 5 p.m. Prof. Dr. B. H. Putnam, "The Transformation of the Keepers of the Peace into the Justices of the Peace (1327-1380)."

Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7 30 p.m. Prof. Dr. A. L. Mellanby, "The Essentials of Engineering Education."
At the Engineers' Club, Manchester. 7.15 p.m. Mr. W. J. Keily, "Shoe-Making Machinery."

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Mr. H. C. Lancaster, "The Lead Industry."

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Mr. B. Campbell, "Nitrocellulose Lacquers."

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Mr. A. J. Bull, "Some Colour Problems in Photo-Engraving."

Refrigeration, British Association of, at the Institution of Mechanical Engineers,' Storey's Gate, S.W. 5.30 p.m. Mr. G. W. Daniels, "Some Possible Developments in Marine Refrigeration."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Prof. Dr. W. Martin, "Jan Steen."

FRIDAY, JANUARY 11..Astronomical Society, Burlington House, W. 5 p.m.

Chemical Industry, Society of, at the Royal Society of Arts, Adelphi, W.C. 8 p.m. Meeting of the Chemical Engineering Group.

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. "The Rational Utilization of Coal." (1) Mr. W. J. Drummond, "Coal Used in its Raw State." (2) Dr. W. T. K. Braunholz, "Fuels obtained by the Treatment of Coal."

Oil and Colour Chemists' Association, at Milton Hall, Deansgate, Manchester. 7.30 p.m. Dr. J. J. Fox, "The Examination of Paints."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Mr. L. C. Wharton, "Dialect Developments."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. Robert Campbell, "Mountains and their Origin." Lecture IV. "Structures of Folded Mountains."

Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Mr. J. McDougall, "Canvassing as an Adjunct to Trade."

THE MODERN WELDLESS STEEL TUBE.

HOW IT HAS INTRODUCED A NEW PHASE OF MANUFACTURING.

In these days of keen competition, more than ever before, it is important that engineers and manufacturers should be fully informed as to developments in methods of manufacture; but now and again we find the adaptability of certain processes so rapidly encroaching upon established practice that many opportunities are lost before advantage is taken of the new conditions.

Such is the position of the weldless steel tube to-day. Manufacturers are so accustomed to look upon it merely as a " tube " in the accepted sense of the word, that they have not fully realised the possibilities of tube drawing processes in other directions.

The modern weldless steel tube is a very different thing from its prototype of a few years ago. It represents a method of manipulating steel into almost every conceivable shape. In one particular mill no less than 800 different shapes, or " Special Sections," are drawn, apart from the usual range of sizes in the round. Many of these special sections are used, not as "tubes," but as structural components, being either cut down to specified size or manipulated into any conformation desired; and the advantage of the multiplicity of shapes available is multiplied by the forms of manipulation that may be applied to them. They may be tapered, butted, bent, screwed or tapped, trapped, bulged or reduced, spun, flanged, slotted, domed; brazed, welded or soldered; plated, coppered, or galvanized.

The importance of this highly-specialised process to engineers and manufacturers cannot be over-estimated—particularly as it is an economical process, productive of clean, well-finished work which compares favourably with any other method of production.

As compared with pressings and stampings, the modern weldless steel tubular product gives a better finish at practically the same cost.

As against castings, tubular processes have the advantage of better surface and less machining, and they do not destroy the ductility of the metal.

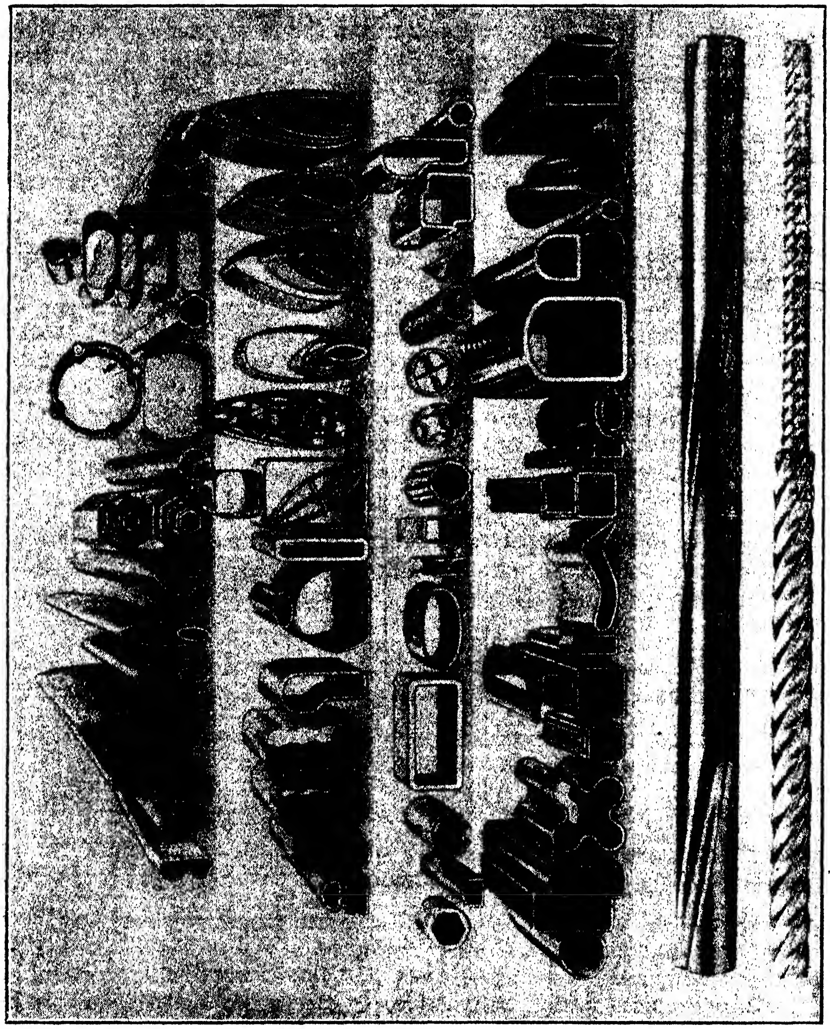
As a substitute for solid metal, they eliminate costly machining operations.

For articles previously made from wood, tubular construction offers greater strength and durability, without added weight, and cuts out a lot of finishing work.

The modern weldless steel tube is applicable to the requirements of hundreds of industries, many of which have already discovered in it a means of simplifying production, increasing output, reducing costs, and improving quality and finish. Tubular products are used in the construction of thousands of articles, and are in daily requisition for component parts of plant and machinery.

The possibilities of the modern weldless steel tube are only beginning to be realised. The essential fact is that we have a process by which steel of all grades, from " low carbon " to chrome molybdenum and stainless, may be economically worked—a process that bids fair to revolutionize manufacture in many directions.

[*See illustration overleaf*]



Some idea of the versatility of the Cold Drawn Weldless Steel Tube for general manufacturing purposes may be gathered from this illustration. It shows a selection from about 800 different Special Sections produced by one firm from stock dies. These Special Sections are adapted in various ways to meet the requirements of many different industries

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, JANUARY 11th, 1929.

All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 16th, at 8 p.m. (Ordinary Meeting.) PROFESSOR CHARLES R. DARLING, A.R.C.Sc I., F.I.C., F.Inst.P., "The Domestic Smoke Problem—a Practical Solution." DR. MARGARET FISHENDEN, D.Sc., F.Inst.P., of the Fuel Research Division, Department of Scientific and Industrial Research, will preside.

DR. MANN JUVENILE LECTURES.

The first of the two juvenile lectures annually given under the Dr. Mann Trust was delivered on the afternoon of Thursday, January 3rd, by CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, on the subject of " Ships."

SIR GEORGE SUTTON, Bt., Chairman of Council, presided

In this lecture Captain Sir Arthur Clarke related the story of the ship and the sailor from Noah's Ark down to the present time. His story, told in breezy style, was woven round the various types of ships which succeeded each other down the centuries, and the sailors who fought and traded in them—the coracle of the ancient Britons, very similar to that used on the West Coast of Ireland to-day, the Roman galley—a type which survived in the Mediterranean well into the age of steam—the ships of the Norsemen, and the Saxon ships built by King Alfred to fight them at Charmouth and elsewhere, the carrack of the 15th and the galleon of the 16th century, the Spanish Armada, the sea-fights of Blake and Van Tromp in the 17th century, the Barbary corsairs, the broad-side ship of the line and frigate of the 18th century, and finally the age of steam culminating in such leviathans as the *Mauretania* and *Royal Oak*. Sir Arthur Clarke, who began his sea service in the East Indiaman " Geraldine Paget " in 1872, added a personal touch to a most interesting lecture by illustrating some of his remarks from actual incidents which had occurred in the course of his long experience.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 5TH, 1928.

THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., in the Chair.

The following paper was read:—

FUEL FOR SHIPS.

By SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S.

The Royal Society of Arts having invited me in the early part of this year to read a paper on the subject of Fuel for Ships, I agreed to do so, as the subject is naturally one in which I take the greatest interest. I fear, however, that the present is not a very good time for dealing with the question. Several very interesting papers have recently been read, and a good many experiments have been, and are still being, carried out with fuel for ships; thus the matter, in a sense, is in the melting pot. Therefore, at the moment, I can only endeavour to place before you the position as it exists at the present stage, and mention some of the latest developments which have been made.

The whole question is really one of economy for the ship owner, and there are so many factors which differ widely in the many services which ships of various classes perform that it is quite impossible to lay down any golden rule on the subject.

There is, I think, no disagreement whatever about the fact that liquid fuel of one kind or another is the most convenient in every way for use on board ship. The advantages of liquid fuel are chiefly the following:—

It can be easily dealt with and quickly delivered on board without any of the trouble, labour and dirt, and difficulty of stowage, which is so apparent when taking in coal. Liquid fuel can be stowed in almost any position in the ship, and thus spaces which are practically useless for cargo or any other purposes can be used without difficulty for the stowage of liquid fuel. From these fuel bunkers, wherever they may be, it can be readily drawn and delivered, either to the boiler or the Diesel engine, as the case may be.

In the early days of the stowage of oil fuel in bulk, and its use, great apprehension was felt regarding the possible danger of fire; but with the exercise of reasonable care in arranging the stowage and seeing that the containing bulkheads are oil-tight, very little risk has been experienced, and it has been possible to ease the regulations considerably regarding flash point when using oil in ships, owing to the general immunity from accidents which has been experienced in its use. There have indeed been very few fires in ships from

this cause—no more, I think, than occur owing to fires in coal bunkers ; so this objection was, at a very early stage in the use of oil fuel for ships, practically eliminated.

On the other hand, in the case of the heavier oils, which become solidified by cold, in a great number of instances ships have to be provided with special heating arrangements to keep the oil in a liquid condition. This, of course, involves a certain amount of expense and weight in arranging the heating coils ; but there has been no great difficulty, and the cost has not been in any way excessive.

I had the honour, in the capacity of Assessor from the Admiralty, of attending the Oil Fuel Commission in 1912 and 1913, which was so ably presided over by the late Lord Fisher. The greatest authorities came before that Commission, and as a result the vast advantages of oil fuel for Naval ships, as against coal which had hitherto been exclusively used, became so apparent and were so clearly set forth in the Report, that steps were immediately taken for the provision of oil storage for the navy at various fuel stations, and, practically from that date, every fighting ship in the Navy was arranged to burn oil instead of coal. Ships which were then being designed at the Admiralty to burn coal were altered to burn oil, and some of the older ships were converted for the purpose. It was pointed out that the ease with which oil fuel could be put on board and also delivered to the boilers, saved all the arduous work of coaling and coal trimming, and practically all the work of firing the boilers, which had hitherto absorbed so much labour in our warships. When a ship returned for fuelling, instead of the crew having the very strenuous work of coaling against time, they had a rest while the oil fuel was being taken on board. They were thus refreshed and fit to do any work required of them when the ship put to sea again, ready for action.

The result of the adoption of the recommendation of the Oil Fuel Commission no doubt had a very marked effect on the Naval Campaign of the Great War. Our ships were less time in port ; they were able to maintain their speed over long periods to an extent which it was almost impossible to achieve with coal.

It is, in fact, no exaggeration to say that but for the introduction of oil fuel many of the ships built for the Navy with very high power and speed would have been impossible had coal been the only fuel ; and had this been so during the war a much longer time would have been spent in port than was the case with oil, so that virtually the numerical strength of the fleet would have been reduced.

Since the adoption of oil fuel, there has practically never been the least question at the Admiralty or in naval circles that liquid fuel is indispensable for Naval ships.

A further advantage of oil fuel as against coal is that, as I need hardly mention, the calorific value of oil being considerably higher, the same weight of oil gives a very much greater radius of action than coal.

The complete adoption of oil fuel for the Navy naturally had its effect on the minds of those dealing with vessels of the mercantile marine; especially with the high speed vessels with large power, which required very big staffs of firemen, trimmers, etc., to run them, and took a long time coaling with the concomitant inconveniences and time in port turning the ship round. A good many of the Atlantic liners were accordingly converted to oil fuel, and new ships were designed to burn oil fuel. For the slower class of boat-- tramps and the like---it was generally found not economical to adopt oil fuel for raising steam, the extra price of the oil exceeding the saving which could be made by reduction of the crew and the time saved in turning the vessel round. This latter is only a comparatively small percentage of the total time occupied by the usual long round voyage of the cargo-carrying vessel.

These advantages of oil fuel no doubt so impressed all concerned, whether engineers, shipbuilders, or ship owners, that when the Diesel engine became a practical engineering proposition and they found that it only required about half the amount of oil that an ordinary steam engine required when burning oil for steam raising, the tendency was for everyone immediately to look to the Diesel for the great improvements in economy which would result. This development in the use of the internal combustion engine is reflected in the record book of Lloyd's Register. The latest edition gives the following figures, viz.:—

In July, 1919, there were 912 motor ships with total gross tonnage of 752,000 tons.

In July, 1928, there were 2,933 vessels with total gross tonnage of 5,432,000 tons, whilst during the same period vessels fitted for burning oil fuel—as recorded in Lloyd's Register record book—increased from 5,336,000 tons to 19,053,000 tons. A large number of the ships built during the last ten years were oil tankers—the totals of which increased from 2,929,000 tons in July, 1919, to 6,620,000 in July, 1928. These figures shew the enormous increase in the amount of oil used for various purposes, which is now carried in bulk.

The result of all this is the present terrible state of the coal trade in this country. Not only are we losing the money on our largest export—coal—but money is going out of the country to buy oil fuel, which, generally speaking, comes from non-British countries; and there is as a result an enormous increase in unemployment in this country.

That this is widely realised is now clear; and I may quote some remarks made recently by the Chairman of the Buenos Ayres Western Railway, which are typical of what is happening throughout the world. At a meeting of the company, held on the 23rd October, 1928, he said:—

"From the point of view of our coalfields at home I am sorry to have to report that very satisfactory progress is being made with the development of our oilfield in the Argentine. We consumed last year in our own locomotives and power house our one-third share of the production available. Moreover,

petrol is now being made on our field, and Diesel oil can, of course, be produced, so that we have at hand the prime elements for the Diesel and petrol engines that we foresee will be required by us, not only on the railway, but on the roads and even in the air, in the future."

Here is another of our markets for coal disappearing, and as I have already said, this is only one example of what is happening far and wide.

From all this it is abundantly clear that no stone must be left unturned to find every possible use and market for our coal, and we must certainly use it as a fuel as far as it is economically possible to do so in all British-owned machinery, including our ships. Unfortunately, a great deal of time has been lost in bringing this aspect before all concerned. So struck was everybody by the economy of the Diesel engine, that early in 1925—that is, about four years ago—Sir Fortescue Flannery said in a paper he read in this hall, that he believed the use of Diesel machinery for navigation would become so common that only for special purposes would the steam engine be able to hold its place. This statement was quoted about three months later by Sir John Biles, at a meeting of the Naval Architects in April, 1925, and he proceeded in a most interesting paper to shew that with the prices then holding (which still approximately hold good to-day) a vessel with the latest type of steam turbine with higher pressure and temperature could be run more economically with coal than a vessel with a corresponding Diesel machinery plant. The fact is, that since the introduction of the Diesel engine with its undoubted economy in burning fuel, great improvements have been made in the economy of steam turbines with suitable high pressure boilers. These improvements have been largely due to the work of our Chairman to-night, Sir Charles Parsons. I think if ship owners had realised the extent to which these improvements had been carried, many of them would not have decided upon Diesel machinery without more thought. This being the case, in view of the serious position of our greatest export industry, it would seem to be a patriotic duty for all who can do so to enquire fully into the possibilities of using coal rather than oil in their ships. The engineers and shipbuilders in this country are, I think, doing everything possible in this direction ; and it is necessary to have the full co-operation of ship owners and coal owners and the blessing—if nothing further—of the Government, to help such a good cause and to restore as soon and as far as possible the prosperity in the most important of our export trades.

All these points were brought out at a recent World Fuel Conference ; but such a flood of information was forthcoming thereat, that it to some extent acted as a smoke-screen and made it difficult for the ordinary man to see the wood for the trees ; but, as has been pointed out by Sir John Biles and others, even at present, with the means at our disposal, coal can be used as a fuel for ships in many cases with greater economy than oil, when burnt in the most economical way. There still remains, of course, the great advantage in all ships which accrues from the use of liquid fuel as against solid. It would be impossible

in this paper to go into all that had been done by the Fuel Research Board and other investigators in regard to coal and other fuels, whether in the laboratory or on the larger practical experimental scale. In a recent report made by the Fuel Research Board it was stated that even if the low temperature carbonisation of coal could be made entirely successful, it could not be expected to supply suitable oil in sufficient quantity to make this country independent of oil imported from overseas. It appears, therefore, that we are left with the necessity of as far as possible using coal in its solid form; and reducing to a minimum, not only the first cost, but also the cost of conveying it to the furnaces, and burning it to the best advantage.

A great deal of very valuable experimental work both in the laboratory and on a large scale has been done in this direction. Reference must therefore first be made to the use of mechanical stoking appliances. These naturally make for the economical use of coal, reducing the stokehold personnel to a very small number compared with the old method of firing the boilers. The coal must also be placed on board by the most efficient methods of transport. A good deal more has been done abroad than in this country in the way of transporting coal to the ports. Greater use is made of conveyors, with the result that coal is much more quickly dealt with in many foreign ports than it is in this country. This point, it appears, should be specially taken up by the coal owners and shippers in order that the reproach one often hears that ships can be coaled much more quickly in, say, Dutch ports, than in our own East Coast ports, may be removed.

As small coal is necessary, either for use with mechanical stoking in the boilers or for pulverising purposes, plant can be specially developed, as has been indicated in recent papers, by which coal can be pumped along pipes into bunkers much in the same manner as oil is put on board. This method has already been carried out successfully on land with pneumatic plant, and lends itself to development for use in connection with the coaling of ships. With such arrangements and with the adoption of mechanical stokers, which are already being successfully used at sea, a great deal of the man-handling of coal is done away with; and the number of men required in the stokeholds with good mechanical stoking appliances is reduced nearly to that prevailing with oil fuel boilers.

In ships recently built for the Canadian Pacific Steamship Company these mechanical stoking appliances are functioning very satisfactorily, and I understand the owners are very satisfied with the results they are obtaining, both in economy and general convenience. In these vessels boilers are of the water-tube type, some of the ships being fitted by Messrs. Yarrow & Co., and others by Messrs. Babcock & Wilcox. The boilers have a pressure of 250-lbs. and are fitted with superheaters. I believe that Mr. Johnson, the owners' General Superintending Engineer, is hoping to publish more information about this matter in the near future; so that I cannot say very much more

in connection therewith at present. In some of the Canadian Pacific passenger ships higher pressures up to 350-lbs. have been used.

A further approximation to the use of liquid fuel in ships is made by the pulverisation of coal. This development, as you know, though still to some extent in the experimental stage, has recently made great advances. A very interesting paper on this subject was read before the Institution of Naval Architects in July, 1927, by Engineer-Captain Brand, R.A.N. Captain Brand gave a great deal of information in his paper explaining the nature of various experiments carried out, and especially those made by the Naval Board in Australia. In the official report of the supervising officers it was stated that they considered the following points had been proved :--

(1) That powdered fuel can be burnt satisfactorily as compared with other fuels for warship purposes.

(2) That it can be conveyed continuously and efficiently from a ship's bunker to a furnace, and the combustion and smoke production regulated as easily as with oil fuel.

(3) That fuel can be delivered into the bunkers easily and efficiently.

(4) The conveying machinery, fuel supply, etc., can be installed at comparatively low cost, without undue loss of power or excessive weight.

In these experiments and in the methods advocated by Captain Brand, the proposal is to carry powdered fuel in bulk in the ship's bunkers ; thus doing away with the pulverising plant working on board—some form of which is otherwise necessary in connection with the use of powdered fuel.

In the adoption of such a system there is first of all the question of danger of explosion when powdered fuel is used in this manner, and Captain Brand proposes to eliminate this danger by the introduction of inert gases from the funnel, thus guarding against the existence of an explosive mixture. I cannot help thinking that there will be great difficulty in making any such arrangement practicable. On the other hand, I am doubtful whether the danger is very great, and am inclined to class it with the danger bogey which was so prevalent in the minds of many who feared the consequences of the adoption of oil fuel ; and which in the end proved to be easily provided for. The chief objection to the use of powdered fuel in bulk appears to be the difficulty of storage, involving not only arrangements in the ship's bunkers, but also the provision of tanks on shore at various coaling stations ; with special provision in both cases to keep the powdered fuel absolutely dry. This provision would involve an enormous outlay and take a long time to establish—just as the arrangements for oil fuel have been gradually developed with storage tanks at various ports all over the world.

In the meantime, until we learn more about the use and storage of powdered fuel, I cannot help thinking that the most practical method of using pulverised coal for ships is to carry the pulverising plant on board and to pulverise the coal as it is required. Various experiments have been made in this direction,

both in America and in this country. You have all probably read about the experimental plant fitted in the *Mercer* under the supervision of the U.S.A. Shipping Board. A great deal was learnt from this; but it all shewed that a good deal has yet to be done to make the arrangement thoroughly successful. I think, however, that the experiments carried out in the *Mercer* were perhaps most useful as an object lesson to those interested in the use of coal. America is practically the home of oil fuel, and if they had no coal at all, oil is available in unlimited quantities, at comparatively low prices, for fuelling ships. In spite of this, the Americans saw fit to spend large sums experimenting on the new use of coal as a fuel for ships, although the export of coal is not by any means a vital matter in the trade conditions of the U.S.A. On the other hand, although the matter *is* a vital one to this country, no experimenting on a big scale and with the assistance of the Government has yet been made in the same direction here. At the present time in this country the greatest advance made in the use of powdered fuel has been carried out entirely by private enterprise. Several engineering firms have done a great deal of pioneer work in connection with the use of powdered fuel, involving experiments with burners, pulverising plant, with boilers, and with distributors. These include experiments by Messrs. Yarrow & Co., Messrs. Babcock & Wilcox, and Messrs. Clarke, Chapman & Co. The last-named firm seems to have gone a long way towards perfecting burners and pulverising plant, and have been experimenting for quite a number of years. The bulk of the work done here hitherto has been with land installations; and a great number of pulverising plants are now in use in land boilers, in collieries and other works, giving most satisfactory results. Low grade coal of small value, costing often less than 10s. per ton, is being pulverised and used most efficiently and economically for power plants. Based on these practical results, experience with land plants has been used to produce pulverising arrangements fitted to marine boilers, which show very great promise. The first marine plant actually fitted was in a cargo vessel of the Blue Star Line, the *Stuart Star*. One of the four furnace, single-ended boilers was adapted with a "resolutor" mill and "Woodeson" burners, and was in continuous use throughout the voyage to the River Plate and back. The experimental installation gave such excellent results in service, and the Blue Star Line were so satisfied that they ordered the conversion of the double-ended boilers for pulverised fuel; and I understand it is their intention to adopt similar arrangements in one of their passenger liners.

There have been many difficulties to overcome in the use of powdered fuel. First of all, a suitable burner had to be designed, and Messrs. Yarrow & Co., Messrs. Clarke, Chapman & Co., and others have developed very satisfactory ones. I do not propose to go into details of the various burners—Peabody, Buell, etc. The same experimenting and research had to be done in connection with oil burners before a suitable type was developed, but the difficulties were

all overcome, and apparently the same measure of success has been reached with powdered fuel burners. To burn powdered fuel satisfactorily it is necessary to have it in a complete state of turbulence in the furnaces and to have a flame which is not too long. This result has been achieved with recent burners, and the Clarke, Chapman Patent Burner can be seen at work in their experimental marine boiler at Gateshead.

Last spring, before the Liverpool Engineering Society, Mr. W. E. Woodeson, B.Sc., of Messrs. Clarke, Chapman & Co., read a paper on "Pulverised Fuel for General and Marine Purposes." This gave a very good and clear account of the work which has been carried out in the development of Messrs. Clarke, Chapman's Pulverising Plant, and I would commend this paper to the attention of anyone interested in the subject, as well as the earlier paper by Captain Brand. Mr. Woodeson describes the experiments made for marine boilers as gradually developed from the use of their plant with land boilers. He also describes the various burners and shews how arrangements have been made to reduce the length of the flame to the proportions required for success in marine installations. He gives the cost of pulverising, which requires about 14-K.W. per ton of coal pulverised per hour ; the cost of repairs to the pulveriser itself varying from *2d.* to *8d.* per ton, according to the quality of coal used. In their pulveriser the wearing parts of the machine are easily accessible and can be readily renewed. I certainly think the arrangement for pulverising in their so-called Resolutor machine—which is brought about by impact—is simpler and cheaper than that which has been generally used in America, by rotating balls in the pulveriser.

In the latest machines various kinds of coal may be used—from a good, down to a very poor quality—and the coal may have a considerable amount of moisture in it, amounting to as much as 10 per cent. or even more, and can be dealt with in the pulveriser. Very great fineness of pulverising can be achieved, this being a very important point, in order to get the most perfect combustion.

There is, I think, a great deal still to be done in the matter of coping with the ash resulting from the burning of pulverised fuel, but all these points are being thrashed out by the boiler-makers, especially Messrs. Babcock & Wilcox, who are devoting much attention to the subject.

Finally, there is the question of the entire cost of the arrangement. I am frequently asked by ship owners, especially in connection with tankers and cargo boats, whether in my opinion they should adopt Diesel or steam engines. The question always involves a long investigation into the particular service for which the ship is intended, and the price for the necessary fuel at the different ports or terminals at which the vessel is to call. I may perhaps say that in a good many instances of late a decision has been given in favour of steam when originally a Diesel engine had been contemplated. There have, on on the other hand, been cases where a Diesel instead of a steam engine has

been installed, which shews that the question is one which cannot be settled easily or in an off-hand manner.

With the use of coal in powdered form we have a fuel which in its use and action very nearly approximates to oil. It can be used in suitable water-tube boilers as well as in the Scotch boiler, and can further be adopted for high pressure boilers with high temperatures and the greater resulting economy.

No doubt great improvements will be made in boilers specially designed for the purpose—perhaps with water-cooled walls for the combustion chamber—and as these improvements develop, I look for considerably greater economy with the use of steam and high pressure turbines, with powdered coal as the fuel, than is given in his papers by Sir John Biles.

In advocating the use of steam as against the Diesel engine, and the economy of coal versus oil, it seems to me that in the comparison he gives Sir John has taken a rather high price for coal. His figures shew that a high pressure steam outfit is more economical over a voyage of a little more than 14,000 miles in length. If a lower figure is taken for the price of coal—and I see no reason why it should not be, especially with the use of powdered fuel—its advantages are still more pronounced, and make for a still longer voyage or a greater saving in running costs.

It may be objected that the pulverising plant on board takes up valuable space in the ship, and this is certainly true. The question of stowage of coal, whether for mechanical stokers or for pulverising, calls for a good deal of consideration, and there is room for improvement. It is necessary in every case to have a ready-use bunker in a position immediately over the stokehold; and the coal from the main bunkers has to be conveyed to this ready-use bunker. I believe, however, that it is possible to so design a ship that the main bunkers can be made much more self-trimming towards the ready-use bunker than has generally been done hitherto. In this connection proposals have been made in the case of certain ships in the U.S.A., and I believe the question has received consideration in some designs in this country; but I do not think much has been done in this direction up to the present. Of course, such bunkers occupy valuable space, but if the ship is designed with this point in view at the start, the advantages to be gained are sufficient to warrant the use of some of the space so required. On the other hand, there is no reason why water-tube boilers should not be increased in size—as has been done in the case of oil fuel—so that the number of boilers required may be reduced and the loss of space thus regained, and thereby the adverse economical point of valuable space been taken up can be largely removed.

To sum up the whole situation, there is no question about the convenience or efficiency which can be assured with the use of oil; the great objection being the high cost. If the ratio of cost of coal to that of oil fuel remains as at present, or even if oil costs somewhat less, it is thought that with the improvements which are being rapidly made to use coal and steam in the most economical

manner, there is no reason why it should not be found that it is as unwise economically for British ship owners to arrange for their ordinary cargo ships to burn oil imported from Texas or the Persian Gulf, as it would be for American ship owners to insist on coal for a line of vessels plying from California or the Gulf of Mexico.

In order to develop the use of coal for ordinary British cargo boats, the transport and conveyance of coal to the furnace must as nearly as possible be accomplished in a similar way to that which is done with oil fuel, so as to reduce labour costs to a minimum. This can best be done, first by the use of small coal and mechanical stokers; and a still further advance will be made if the use of powdered fuel can become thoroughly practicable. For the latter, the object must be to arrive at such an arrangement combining, in a suitable water-tube boiler, burners and combustion chamber which can deal with any ordinary type and condition of coal, so that the owner may feel confident that his vessel can successfully operate with bunker coals obtained at any of the ordinary coaling stations throughout the world.

DISCUSSION.

The Chairman said that at the present time a survey of the whole situation was exceedingly important. In electrical generating stations throughout the world there were very few Diesel engines of over one thousand horse-power, the only exception, to his knowledge, being one of 15,000 kilowatt capacity in Hamburg. The obvious question arose what difference existed in the conditions on board ship, and on land, which acted favourably or unfavourably in the comparison between the steam engine and the oil engine, and also between the use of coal and oil. Sir Eustace d'Eyncourt dealt very fully with those and other questions.

There could be no doubt, however, as to some of the conditions on board ship, which could be considered more favourable to Diesels than to steam, and also to oil as compared to coal as fuel under boilers and vice versa. Sir Eustace d'Eyncourt had dealt very fully with these questions, and there seemed no doubt that this important subject required thorough practical investigation. A great deal of money had been spent on low temperature carbonisation, but the development of the burning of coal on board ship had hitherto been comparatively speaking neglected. There was a great deal of spade work to be done as to the best methods of handling the coal on board and into the ship.

Sir John H. Biles, K.C.I.E., LL.D., D.Sc., said the last time he had had an opportunity of speaking on the subject had been on behalf of the Naval Architects and in defence of a paper which he had read as one of a series of papers on the matter which had been so admirably dealt with by the lecturer that evening. The lecturer's judgment in the matter was most valuable; his wide experience, both in connection with the navy and the mercantile marine, must impress one with the value of that opinion.

There were always two views to be taken of a subject. One view could be expressed in adjectives and the other could be expressed in figures. When he had been lured into a discussion with the able supporters of oil and the Diesel engine, he had found himself very much on the side of figures, while his opponents

had been very much on the side of adjectives. In the matter of oil *versus* coal, he had happened to be present at a meeting at which Sir Fortescue Flannery, who was supported by the late Lord Bearsted, had waved the flag of oil and had followed it up by going to the funeral of the steam engine.

The lecturer had pointed out that oil went into spaces into which coal would not go. That was true, but that was not the end of it. One wanted to know what it cost to carry coal in the space in which it was carried, and how much one gained by carrying oil in the space in which it was carried, and whether, even if a bigger ship had to be made to carry the coal, it was not cheaper to make that bigger ship than it was to have a smaller ship and carry oil in the spaces which otherwise could not be used, and make use of the advantage of oil in other ways. He had tried to work that problem out in his own paper and, rightly or wrongly, had come to the conclusion that steam was not altogether dead, and that the advantages which Sir Charles Parsons had been able to bring to the assistance of steam were sufficient, at any rate, to make it not certain that it was dead.

The lecturer had very wisely referred to the work which Mr. Johnson, of the C.P.R., had done. Mr. Johnson deserved a great deal of credit for the courage which he had displayed in undertaking that pioneer work. He was also to be congratulated on his good fortune in having got his owners to follow him in the matter. Johnson had reached a condition with the turbine in which he had been able to get an equal h.p. with two-thirds of the quantity of oil which was required in 1922. The last ship which he (Sir John Biles) had had to deal with belonging to the C.P.R. had been a ship with oil and turbines, but with the development which had been courageously adopted by Mr. Johnson, Mr. Johnson had been able to take off one-third of the consumption of the oil. That was going a good deal towards making the unit of fuel per h.p. nearer to that of the Diesel engine; and when one took into account those things which were to the disadvantage of the Diesel—its first cost and its weight—one was getting in actual practice to the state where the steam engine was at least equal to the oil engine.

With regard to the statement that the Admiralty had come to the conclusion that they had no use for coal, that was not quite true; except for the extreme purposes of the Admiralty, namely, for obtaining the highest possible speed, oil was not indispensable. But the highest possible speed was not needed all the time. It was not needed in peace. The Chairman would approve of the statement that a good deal of the Admiralty work might be done with coal instead of with oil, especially as seemed to be the case now, when burners could be put into water-tube boilers, which could be used either with oil or with pulverised coal. If the Admiralty could use in their avocations alternatively pulverised fuel and oil with the same burner, perhaps they might save a little of the importation of oil which everyone deprecated so much.

Many years ago he had worked on a design in which one of the conditions was that all the coal on the ship should gravitate to the firing station. If that condition of affairs was obtained—where the coal gravitated to the crusher or the pulveriser—there was no more trouble about the flow of the fuel to the furnace than there was in the case of oil being pumped to the furnace by the oil pump.

The paper was an admirable summing up of the whole situation, and it would be of very great use to those who were interested in the subject.

Engineer Captain W. Onyon, R.N., remarked with regard to the safety of powdered fuel in ships, that the lecturer had referred to the question of fires. When oil fuel had been first introduced into the Navy he had happened to be the chief engineer of the first "Dreadnought," which had carried 3,000 tons of coal and 1,400

tons of oil fuel, which they had tried to burn together. The number of fires which had occurred in the ship had never been published, but there had certainly been ten serious fires, without even the captain of the ship knowing anything about them. Perhaps the audience might be rather surprised to know how those fires had been put out. They had been put out with powdered fuel—coal dust and ashes damped! When he had suggested to the Admiralty the introduction of sand into warships for the putting out of fires, he had been looked upon as a lunatic, but now nearly every ship carried a sand box in its boiler room. The introduction of powdered fuel into ships would certainly be delayed until some absolutely reliable method of putting out fires had been designed. If the fuel was dealt with on board ship it was a very different proposition; but if powdered fuel was going to be put direct into the bunkers, very careful precautions would have to be taken against fires, and until those precautions were perfected he could not see himself how powdered fuel was going to be introduced into ships.

He would like to ask the lecturer what amount of foreign matter was found in pulverised fuel at 10*s.* a ton. He could not think it was all coal, and he thought it was uneconomic to pay freight for something which could not be burned and for something which had no calorific value. Fuel at 10*s.* a ton was bought, and the result was that there was a good deal of trouble owing to the amount of slag in the furnaces.

Engineer Captain Brand said reference had been made to the necessity of bolstering up the coal trade, coal being practically the only product in this country which was native to the country and which could be sold outside the country. One would have thought that the Government would have seen years ago, as others who had been working on the question for the last fourteen years had seen, what the coal trade of this country was coming to. However, they had not, and neither had the coal owners. The resuscitation of the coal trade was an absolute necessity for the life of this country. There was also one other feature which was of importance, and that was the resuscitation of the boiler shops of the engineering firms of this country. In going round the country one could not help being struck with the disparity in the distribution of work between the shops of engineering firms according to their design and lay-out. The general introduction of the Diesel engine had meant big foundries and a tremendous number of machine tools, with a high grade of workmanship, to the almost utter abandonment of the boiler shop and, to a certain extent, of the sheet iron trades.

Sir John Biles had for many years been a stout supporter of steam, always backing Sir Charles Parsons. Those two gentlemen had fought the good fight for steam year in and year out, and they had been right. The day before yesterday he himself had had occasion to draw up some figures for a ship of 3,000 h.p. Taking the ruling price for oil, and taking the absolute quotation of 9*s.* 2*d.* per ton for slack coal of 13,250 B.Th.U., and ordinary bunker coal delivered alongside at 14*s.* 9*d.* per ton—on that basis, and taking the results of Sir Charles Parsons' work, as to a large extent exemplified in the work of Mr. Johnson, and using Mr. Johnson's figures of .68 lbs. of oil per shaft h.p. hour, he had found that the oil for that ship, including all charges, based on a consumption of 100 tons of hand-fired coal per day, had worked out at £223, and the pulverised fuel, pulverising on board, taking all charges of every description into account, including disparity in freight and stowage, had worked out at £194.

The time had passed when it would be necessary for Sir John Biles to take the platform on behalf of the steam engine. The steam engine with powdered fuel,

high pressure steam and superheat, had arrived, except in special trades, and those special trades everyone knew.

For marine work, efforts so far made in America and in this country had used the direct or unit system of firing. This had entailed many difficulties in distributing the powdered fuel equally between the various furnaces, thus lowering the over-all efficiency. In addition, the unit pulveriser was fundamentally incapable of maintaining an even efficiency at different rates of burning. In fact, its efficiency was negligible when the quantity of coal fed to the machine dropped to a quarter of the designed output. Very many automatic and mechanical distributors had been designed and tested at the Mare Island Navy Yard, U.S.A., without success. In fact, his experience, and that of all other experimenters, had shown that it was impossible to distribute coal dust borne in an air stream equally among a number of pipes, which probably had slightly different bends and lengths. Many years ago he discarded the direct firing for marine boilers in favour of the bin and feeder system; though for water tube boilers having only one furnace he retained the former. It was gratifying to note that in a paper recently read in America by Mr. Peabody, he advocated for marine work the bin and feeder systems, thus showing that his experience of direct firing on the S.S. *Mercer* and S.S. *Lingan* had converted him to an advocate of a British system of firing. With the latter, it was possible to obtain an efficiency of 83 per cent. at one-sixth and 79 per cent. at seven-sixteenths of the rated boiler output. The latter might be as high as from 7 to 8 lbs. evaporation per sq. ft. of heating surface.

Mr. W. E. Woodeson congratulated the lecturer on his very straightforward statement of the facts. The lecturer had not exaggerated in any shape or form the position with regard to pulverised coal or oil.

With regard to Government assistance, British firms had not received a great deal of that. The United States Shipping Board had placed ships at the disposal of engineers who desired to carry out experiments, but private firms in this country had had to do the work on their own initiative. It was very easy to criticise the efforts of the people engaged in the pulverised fuel industry, but it had to be remembered that the whole matter was only in its infancy as far as the actual practical applications of pulverised fuel were concerned. As a result of his experience during the past two years, he was firmly convinced that if the same relative advance was made in regard to pulverised fuel in the next two or three years as had been made in the last two or three years, we should certainly have nothing to fear as a nation. The Union Steamship Company, the Blue Star Line, and other companies, were naturally going through a period of experiment, and those companies deserved every praise and encouragement from the country as a whole for doing so. They were really doing pioneer work, despite the fact that they were merely private firms. Britishers were of such a type that they immediately handed over any information they gained to all and sundry, and therefore the Blue Star Line and the Union Steamship Company could not expect to huve the monopoly of pulverised fuel in the future; other firms would benefit by it. That was why he was of the opinion that the Government should come to their assistance to some small extent, so that our home supplies of fuel could be utilised.

Perhaps he might be allowed to answer the question of Captain Onyon as to the 10*s.* per ton coal. He had gone round in the *Stuart Star* from London to the Tyne after her last return, when she had done a comparative run. Fifty per cent. of her boilers had been fired with pulverised fuel and 50 per cent. with hand-fired fuel. The coal for pulverised fuel had been a mixture of coal at 9*s.* 2*d.* a ton from

Northumberland with 12 per cent. volatile coal from South Wales. Part of the time it had been 12 per cent. volatile, and part of the time it had been all low grade coal. The hand-fired boilers had been shut off completely, and a run of two hours had been made on pulverised fuel. Then the pulverised fuel boilers had been shut down and a run of two hours had been made on hand-fired coal, which was of the best type. They had obtained two revolutions better results with pulverised fuel than they had with hand-fired, and during that time the hand-fired boilers had never been cleaned—which was a very important point.

Engineer Rear-Admiral W. M. Whayman, C.B., C.B.E., said he desired to put the problem of coal *versus* oil a little more directly before the audience. One thing which had struck him in listening to the paper had been that the lecturer mentioned that when the Diesel engine had become a practical engineering proposition and it was found that it only required about half the amount of oil which an ordinary steam engine required when burning oil for steam raising, the tendency had been for everyone immediately to look to the Diesel. The stage had already been arrived at when it might be said that a very fair comparison between the Diesel engine and the steam engine was .4 lbs. of oil per shaft h.p. for the Diesel and about .6 lbs. of oil per shaft h.p. for the steam machinery, so that at present, three years after 1925, the difference had been brought down by 50 per cent. That was a comparison between the value of the performances of the two methods of propulsion on oil only. If one went a step further and used coal, one was easily able to realise that the advantages which were claimed for coal in steam machinery were well within view, if not already proved.

The point had been stressed that if all the coal which was in the country was treated with the low temperature carbonisation method, and good results obtained in the amount of oil which was extracted from coal, there would not be enough to go round; but if only the industries of the country could be prevailed upon to use coal for their power supply, and let the predominant amount of oil fuel which was obtained from the coal be used for marine purposes, this country might come very much nearer to the point of being self-supporting.

He would like to call attention to a paper which had been published in last week's *Engineer*, which gave a very good *résumé* of the experience in America, which endorsed the view that the stage had very nearly been reached when the powdered fuel proposition had been demonstrated to be a working proposition. If it could be assumed, as it could be, that coal, in which ever form or method it was burnt to provide the steam power, was at least the equal of oil burnt in the internal combustion engine, and if then mechanical means could be introduced for burning coal for steam machinery afloat, he thought it would form a very serious competitor to oil fuel and the Diesel engine.

Mr. Cunningham Craig said he had not had any experience of the use of powdered fuel on a ship, but he had seen what could be done under boilers with powdered fuel—and with powdered fuel of really a most inferior kind. He had seen the retorted residues of a cannel (and a very poor cannel) keeping up a magnificent flame and a magnificent steam pressure in retorting work. When one talked about powdered fuel, one had to consider what kind of powdered fuel. He believed that it would not be economical to powder raw coal and use it as a fuel. To begin with, the storage of powdered raw coal was a difficult and dangerous thing. But there were other kinds of powdered fuel. There came in the great question of low temperature carbonisation. The idea prevalent in this country was that low

temperature carbonisation depended upon the supply of a domestic smokeless fuel. That might be an excellent thing locally, but it was more important to consider the development of a powdered fuel as a residue. That meant that one could work with coal slack. In Scotland at the present day there was something like ten million tons of slack coal produced, and it was almost impossible to get a sale for it. It did not require much pulverising if it was put through certain retorts. Such oil as could be obtained was taken off, and the residue was a powdered fuel which could be used at once, which was safe to store, which was easy to handle, which was of high calorific value, and which would be admirably adapted for use in ships. In that case a very large step would be made towards putting the coal industry upon a firmer basis.

Sir Eustace Tennyson D'Eyncourt, in reply, said that anything which brought before the general public the advantages which would accrue to the nation if the use of coal could be brought about to a greater extent was to be encouraged. For bunkers alone something like thirty million to forty million tons would be used annually in cargo boats, which now were propelled by oil. If the use of that oil could be transformed into the use of coal it would be a huge advantage to the coal trade of this country and would add greatly to the employment in this country.

What was really wanted now was for a ship to be built, making the best use of the latest form of high pressure turbine, and the latest form of burners and boilers, which would give the most economic results, and to try such a ship against a twin ship with Diesel engines. Then, after a period of service, a result would be obtained which all the world could see, and he ventured to think then that coal and steam would come back to their own.

Sir John had accused him of using too many adjectives, but that was a low grade form of verbosity which perhaps the occasion might warrant!

A hearty vote of thanks to the lecturer concluded the meeting.

Dr. G. E. K. Blythe, B.Sc., F.Inst.F., F.R.S. (Edin.), writes:—

Being essentially interested in the design and application of pulverised fuel equipment to various types of boilers, I have had pleasure in reading the remarks outlined in Sir Eustace's paper relative to this method of firing.

He did not deal as fully with this subject as one would have expected, in view of the tremendous developments which have taken place in this country during the past two or three years. Sir Eustace's reference to the convenience of oil fuel for use on board ship will naturally meet with approval from many sea-going engineers. Oil fuel is ideal in many ways for steam generation, but it is criminal to use it for that purpose when the same result can be obtained from a much cheaper and more plentiful type of fuel, namely, pulverised fuel. When boiler efficiencies obtained with oil have been duplicated with pulverised fuel having a B.T.U. cost of approximately one half of that of fuel oil, and duplicated in such a way that the operating problem has been no greater than that of the oil burning apparatus, then it is most opportune that the marine engineers of this country appreciated to the full extent the importance of this method of firing. The possibility of the efficient, reliable and safe operation of pulverised fuel on marine boilers is no longer an hypothesis, but an established fact, demonstrated and proved out under test conditions in various parts of this country and also under actual sea service conditions. For some of the marine trade routes, pulverised fuel can in its present state of development be adopted with every assurance of

satisfactory results being obtained, but in others the application needs further consideration and experiments. Messrs. R. and H. Green and Silley Weir, Ltd., in conjunction with the Buell Combustion Company, Ltd., have carried out some very interesting and very valuable experiments at the Falmouth dockyard. As a result of these experiments, they have developed a new type of burner, furnace front and pulverised fuel equipment. Many kinds and grades of coal have been burnt on their plant—coal sent from India, New Zealand and various parts of the world—the successful burning of which has proved the flexibility of the equipment installed. These experiments have upset the popular fallacy among pulverised fuel engineers that external combustion chambers were necessary in order to combust efficiently pulverised fuel. The combustion equipment perfected during the experimental period is fitted flush with the boiler front; refractories inside the furnace tubes have been greatly reduced in area, and as a result of these experiments, "unknown to many engineers," the s.s. *Hororata* sailed from Falmouth on Saturday, the 8th December, with three boilers fired with pulverised fuel and fitted with up-to-date equipment, which has given very satisfactory results. This installation, although unique, will be rendered absolute in the course of three to six months, because of the rapid development in design of equipment.

Sir Eustace claimed advantages for oil against coal by reason of the former's higher calorific value, which are turned into a disadvantage when considered from the point of £ *s. d.* Taking a coal of 13,500 B.T.Us and oil of 19,000 B.T.Us, with a cost price of 20*s.* and £3 15*s.* respectively, we at once see that for an extra calorific intensity of 5,500 B.T.Us, one has to pay £2 15*s.*, and fine coal can be purchased for pulverising purposes at a figure much below the one quoted above.

The ease of operation does not enter into the question when comparing oil with pulverised fuel, because in many respects the operating problem between the two classes of firing is very similar and will be more so in the near future when it will be possible to convey pneumatically the crushed coal (taken on board in this form) from any bunker direct to the ready use bunker.

Flexibility and reliability of operation with this system has now been proved out on board ship—in fact, the pulverised fuel engineers and experts are using their best endeavours to imitate in every possible respect the operating conditions existing with oil firing. When success has been proved beyond doubt, the rapidity of growth of pulverised fuel aboard ships will be most marked. Further, we shall see in the very near future the marine boiler specially designed for pulverised fuel firing with special regard to the steam raising conditions on board ship.

The application of pulverised fuel to high speed and high power vessels lends itself very well on account of its operating flexibility. The main question is one of cost, not only in the installation of the necessary equipment, whether coal or oil, but in the running cost of a vessel and the price of the necessary fuel during the voyage.

Pulverised coal experiments carried out in marine boilers have proved beyond doubt that the quality of the coal is not of the greatest importance and that certain qualities, useless for steam in their ordinary state, prove well adapted to pulverisation.

The greater use of pulverised fuel would, of course, benefit British colliery companies very considerably and a universal return to the use of pulverised fuel on cargo carrying steamers would be received with approval throughout the country in view of the present terrible state of the coal trade. Every avenue should be explored in order to meet successfully the greatest industrial problem the nation has yet been called upon to solve since "the hungry forties." The

country cannot allow whole townships to remain derelict. It should not be beyond the resources of statesmanship to devise a cure.

Sir Eustace's reference to the impact type pulveriser being simpler and cheaper than the ball mill is not in conformity with the experience gained by engineers who have been connected for many years with both high speed disintegrating types—ring and roller types and ball mill types of pulverisers. It has been proved that no mill in which the coal is pulverised during its passage from the centre to the periphery of a disc when fixed and moving pins are arranged to intermesh, can be relied upon for consistent and continuous pulverisation; the degree of pulverisation falls off rapidly in some types of mills with the wear of the pins and it is impossible to retain the particles in the pulverising zone for a sufficient length of time. Also the high speed of the discs necessary to effect pulverisation when the pins are new contributes to the cost of upkeep, and, furthermore, the power consumption and maintenance are very high. The writer has had experience with these types of mills when the maintenance charges (cost of upkeep) came out at 3s. 2d. per ton of coal pulverised. Ball mills, when properly designed, have been proved out to be very reliable pulverising mills.

In reply to the above communication, SIR EUSTACE TENNYSON D'EYNCOURT writes:—

Since the reading of my paper, some written remarks have been received from Dr. G. E. K. Blythe, B.Sc., etc., which appear generally to bear out and strengthen the arguments used in the paper, in which I endeavoured to point out that with coal costing so very much less than oil as a fuel, even with the great economy of the Diesel engine, *steam* raised by coal burnt in a suitable boiler and finally in the best and most efficient form—namely, in pulverised condition—would beat the Diesel engine burning the high priced oil.

Regarding Dr. Blythe's remarks on the ball mill, no doubt there are very good mills of this description, and experience will show in due course which is the best form of pulveriser.

OBITUARY.

SIR HENRY TRUEMAN WOOD.—We deeply regret to report the death of Sir Henry Trueman Wood, which took place on January 7th at the residence of his son-in-law and daughter, Mr. and Mrs. W. R. Fisher, at Bourne End, in his 84th year.

Henry Trueman Wood was born in 1845. He was educated at Harrow and Clare College, Cambridge, of which he was a scholar. At Cambridge he achieved the rare distinction of twice winning the Le Bas Prize (in 1869 and 1870), which is offered annually for the best English Essay on a subject of General Literature. On leaving the university he became a clerk in the Patent Office, where he laid the foundations of a knowledge of inventions that afterwards became very extensive indeed. He did not remain long in this position, however, for in 1872 he came to the Society of Arts as Editor of the *Journal*: four years later he was appointed Assistant Secretary, and in 1879, on the death of Peter Le Neve Foster, he succeeded him as Secretary, a post which he held for thirty-eight years. Under his guidance the Society gained steadily in prestige and reputation, and the quality of the papers and lectures reached and maintained a very high standard of excellence.

In 1914, with the outbreak of war, the Council were faced with a very grave problem. All societies—nay, society itself—were threatened with unknown dangers. Members, forced from their usual avocations, were compelled to resign in large numbers, and nobody knew what the future had in store. The Council wisely decided to carry on as far as possible in the usual way, and in spite of many anxious times, Sir Henry had the satisfaction of seeing the Society emerge from the period of war little the worse financially for the troubles through which the world had passed.

On his retirement from the Secretaryship, he was elected a member of the Council, and served as Chairman for the year 1919-20. In recognition of his services to the Society he was nominated a Vice-President by H.R.H. the President, under the terms of By-law 73, *b*; and Members of the Council also raised a fund to provide an annual Trueman Wood Lecture, in connexion with which a brilliant series of addresses has been delivered.

Some mention must be made of the "History of the Royal Society of Arts," undertaken by Sir Henry at the request of the Council and published in 1913. Extremely well written, it not only gives an account of the varied activities of the Society from its establishment in 1754 to 1880, when he became Secretary, but is virtually a history of invention during this period. It was a task that required a mind of singularly wide interests and varied knowledge to accomplish, and it contains a wealth of information that he alone possessed. A vast amount of research was required before it could be written, and it says much for Sir Henry's literary skill that he was able to present so readable an account of what in less able hands would have been a mere catalogue of technicalities. He also wrote "Industrial England in the 18th Century," "Modern Methods of Illustrating Books," and "Light," together with numerous articles in newspapers and magazines.

In addition to his work as Secretary of the Society, Sir Henry had a long and wide experience of exhibitions. This began in 1873 with the series of London International Exhibitions organised at South Kensington by Sir Henry Cole. He had also something to do with the Paris Exhibition of 1878 when he edited the Artisan Reports on it; but his chief early experience was in connexion with the Health Exhibition of 1884, when he was Joint Secretary of the Jury Commission; with the Inventions Exhibition of 1885, when he was Secretary of the Jury Commission; and with the Indian and Colonial Exhibition of 1886, when he was Secretary of the Conference Committee and Joint Secretary of the Reception Committee. He acted as Secretary and Commissioner for the private committee which organised the Paris Exhibition of 1889, and was Secretary of the Royal Commission for the Chicago Exhibition of 1893. He was one of the most important witnesses who gave evidence before the Committee appointed by the Board of Trade to enquire into the Participation of Great Britain in Great International Exhibitions, when he strongly advocated the establishment of a permanent department of the Board of Trade to take charge of exhibition work—a policy which has now been adopted.

In 1877, Sir Henry was asked to write a report formulating a scheme of Technical Education for the Committee of the City Guilds which had lately taken up the subject. Reports were also invited from Professor Huxley, Sir John Donnelly, Sir Douglas Galton, Sir William (afterwards Lord) Armstrong, and Sir George Bartley. The suggestions of Sir Henry Wood were practically adopted, and this led to his acting as secretary to the Committee of the City Companies and assisting in their early organisation. In 1879 he was offered the permanent secretaryship, but as he had just become Secretary of the Society of Arts, he declined the post.

For many years he was closely associated with the work of the British Association. He acted as Secretary to Section G (Engineering) from 1878 to 1884, when the Association visited Montreal. After that he gave up the secretaryship but continued to attend the meetings regularly up to 1899.

Outside his official duties, Sir Henry, who had been knighted in 1890, had numerous interests. For a great many years he was a keen student of photography. He was himself an excellent photographer, and was President of the Royal Photographic Society from 1894-96. For many years he served on the Board of Kodak, Ltd., and until recently was Chairman of the British section of the firm. For some thirty years he was a well-known member of the Athenaeum and served on the committee, of which he was for some time chairman. Amongst his most intimate friends there was the late General J. B. Sterling, whose crushing defeat of Herbert Spencer in a game of billiards drew from the disgusted philosopher his classic remark that such uncanny skill was evidence of a mis-spent youth. Sir Henry was also an athlete, for while at Cambridge he ran for the university in the mile race. In later life he played a good deal of golf; he was captain of the Chorley Wood Club and he was also often on the links at Aldeburgh.

Sir Henry had a very wide circle of friends, and in spite of a tongue that could be uncommonly caustic on occasion, he was exceedingly popular. The writer of this notice had the privilege of knowing him intimately for twenty years and remembers with gratitude many acts of courtesy and kindness received at his hands. An occasional pose of cynicism did not go far to conceal a warm and generous heart, which, if it was sometimes apt to be a little impatient of stupidity was always ready to appreciate and applaud real worth.

Κούφα σοι χθὼν ἐπάνωθε πέσοι.

Sir Charles Herbert Theophilus Metcalfe, Bt.—Sir Charles Metcalfe, who died suddenly at his home at Winkworth Hill, Godalming, on December 29th, at the age of 75, was the only child of Sir Theophilus Metcalfe, fifth baronet, of the Bengal Civil Service. He was born on the 8th September, 1853, and was educated at Harrow, where he played for two years in the football XI, and afterwards at University College, Oxford, where he got his "blue" for Rugby football, and also ran for Oxford in the quarter mile in two successive years. In the schools he took a third in classical moderations and a second in law. Oxford was a pivotal point in his life as it was there that he formed a close and life-long friendship with Cecil Rhodes, who went up to Oriel about the same time, the late J. R. Maguire of Merton being another contemporary. When Cecil Rhodes a few years later obtained the grant of a Royal Charter for the Company which he formed for the purpose of extending the sphere of British influence into Central Africa, he undertook to extend the railway northwards from Kimberley, the existing terminus, and indeed the earthworks for the northern extension were begun within a week of the signing of the Charter by Queen Victoria. Sir Charles Metcalfe's firm, Sir Douglas Fox and Partners, surveyed and supervised the construction of the whole of the railway from Kimberley to the Congo, as well as the Beira and Mashonaland Railway, which provided Rhodesia with an alternative route through Portuguese East Africa. Sir Charles Metcalfe was mainly responsible for the line which the railway actually followed and the whole scheme was completed under his personal supervision. He remained the trusted adviser of the British South Africa Company in railway matters up to the time of his death. Sir Charles, who succeeded to the baronetcy in 1883, had been a Fellow of the Royal Society of Arts for nearly 40 years, and since

1921, had been a valuable member of the Dominions and Colonies Section Committee, whose meetings he regularly attended. He also took part from time to time in discussions on engineering subjects at the Society's meetings.

SIR CHARLES WRIGHT MACARA, BT.—Sir Charles Macara, who died on January 2nd, in his 84th year, had been for many years a leading figure in the cotton industry. He was largely responsible for the Brooklands Agreement of 1893, which marked an epoch in the relations between capital and labour in the cotton trade, and was also the founder of the Federation of Master Cotton Spinners' Associations and of the International Federation of Master Cotton Spinners' and Manufacturers' Associations.

He was born in the Fifeshire village of Strathmiglo on January 11th, 1845, his father being the Free Church Minister there. He was educated in his native village and afterwards at Edinburgh until the age of 17, when he entered the warehouse of a Scottish merchant in Manchester. In 1868, after a brief migration to Glasgow, he returned to Manchester to assist in representing there the Dundee jute firm of Cox Brothers, soon rising to be head of the branch; and in 1880 he joined, as managing partner, the old-established firm of Henry Bannerman and Sons, which under his guidance entered upon an era of increased prosperity.

Macara was among the first to support the scheme for the Manchester Ship Canal, and the movement for the encouragement of cotton growing in other countries, especially the British Empire. During the war he was one of the first to declare the necessity of making cotton, from which high explosives are made, contraband of war, and took a leading part in securing that the compulsory Military Service Acts should be administered through local machinery rather than by the War Office direct. He was also actively interested in the National Lifeboat Institution, of which he was an honorary life governor.

Sir Charles, who was created a baronet in 1911, also received a number of foreign orders and decorations. He had been a Fellow of the Royal Society of Arts since 1921.

A NEW ERA FOR FLAX.

So many of Britain's industries are based on textiles that I take the liberty of inviting attention to some new developments in the production of flax fibre, which may before long bring it into the world's markets in sufficient quantities to rival the production of cotton.

The world's acreage of flax in an average year, according to the U.S. Agricultural Year Book, was 15,870,000 acres; of which 4,447,012 acres were for fibre and 11,432,988 acres for seed only. The fact that a much greater acreage of flax is grown for seed than for fibre *and* seed is chiefly due to one of three reasons, *viz.*—shortage of water, lack of labour, and the objectionable nature of the process of retting (rotting) the straw. This process requires some skill and much indifference to foul odours. It consists in submerging the straw until fermentation loosens the fibre from the woody portions of the straw.

When flax is grown for seed only, the sowing is sparse, so that the plants may have room to branch out, but when the objective is fibre straw and seed, it is thickly planted, so that the plants may not have room to branch, except at their tops.

Flax grown for seed on the customary sowing of 30 pounds to the acre yields an average of 8 bushels of seed to the acre, worth \$2.00 per bushel; most of the straw being burned to get rid of it. Flax grown for fibre *and seed* is usually planted

90 lbs. to the acre and yields 10 bushels of seed and two tons of straw ; comparative results being as follows :

Yield from seed flax per acre—8 bushels @ $2.00 per bu.		$16.00
Yield from fibre and seed—2 tons of straw @ $20 per ton ..	$40.00	
10 bushels of seed @ $2.00 per bushel	20.00	
		$60.00

The perfection of a new machine, which threshes and scutches unretted (or retted) flax in one operation with unskilled labour and gets double the yield of fibre hitherto obtained, supplemented by a new de-gumming process, simplifies the handling of flax as compared with that of other crops.

With this new method the farmer threshes and scutches his flax and sells the fibre and seed, and the buyer either processes the fibre himself at a central point or ships it to the spinning mill to be processed there ; thus eliminating the complicated and very objectionable labour of retting, and making it possible to produce a high quality of flax fibre at a cost much below any other fibre on the market.

Detailed costs in the United States and Canada are as follows :—

Per acre—Rental of land	$ 10.00
,, ,, —Ploughing with tractor	2.50
,, ,, —Harrowing twice	1.00
,, ,, —Seeding (90 lbs.)	5.00
,, ,, —Rolling	1.00
,, ,, —Machine pulling	4.00
(Hand pulling costs $11 to $16 per acre.)	
,, ,, —Shocking	0.50
,, ,, —Stacking	2.00
,, ,, —Average haul to mill	2.00
,, ,, —Interest on outlay	1.00
	$ 29.00
,, ,, —Average amount of straw, 4,000 pounds.	
,, ,, —Average yield of fibre with new method, 1,000 lbs. (Double that previously obtained.)	
,, ,, —Cost of threshing and scutching with the new machine ..	15.00
,, ,, —Cost of processing by new method, 1000 lbs. fibre ..	10.00
Total cost	$ 54.00
CREDIT —10 bushels of seed @ $2.00 per bushel .. .. .. (The price of $2.00 per bushel for seed is for seed sold to linseed oil mills. Seed for re-seeding would be worth more.)	20.00
—Net cost of 1,000 lbs. processed fibre .. .. .. or $3.40 per 100 lbs. (new method).	$ 34.00

The present cost of producing flax fibre in the United States and Canada is fifteen cents per pound.

An Oregon flax grower reports 4½ tons of straw per acre from /J.W.S. seed on a 125 acre planting, but this is unusually large.

By the new process, sometimes called de-gumming, the flax is scutched green (unretted) and processed in a few minutes. No acids, alkalis or mineral oils are used. The figures of the world's flax acreage in 1925 are as follows :—

Canada	1,034,874	Lithuania	144,361
United States	2,489,800	Latvia	132,076
England and Wales	7,504	Estonia	75,365
Ulster	36,982	Finland	14,776
Free State	8,288	Russia	2,661,380
Sweden	5,700	Kenya	7,077
Netherlands	27,839	Morocco	40,924
Belgium	47,298	Algeria	648
France	45,508	Tunis	5,588
Spain	3,857	Egypt	3,181
Italy	51,700	India	3,478,000
Austria	9,055	Japan	49,782
Czechslovakia	56,450	Chosen	3,386
Hungary	7,025	Chile	675
Yugoslavia	33,179	Uruguay	116,287
Bulgaria	634	Argentina	5,224,757
Rumania	40,021	Australia	452
Poland	242,006	New Zealand	8,685

There is no other crop so universally grown as flax. Most of the flax grown in the United States, Canada, India and the Argentine is grown for seed only.

Although the new methods are revolutionary in the art of producing fibres, they are all along the line of simplifying present methods, greatly reducing costs and getting uniformity. The farmer can dispose of his flax crop in the same way as his other crops, as soon as his straw is dried and scutched, and he is saved the exceedingly objectionable and expensive process of retting. All who have been approached in the United States and Canada have expressed themselves as eager to make a trial of it, if furnished with the right seed and shown a market for their unretted fibre.

As the fibre is only 28% of the weight of the straw, it costs much less to carry it to its destination.

The new de-gumming process is inexpensive and has no objectionable features, and can best be done at the spinning mill or a central distribution point. The commercial agents of the railroads are also exceedingly anxious to assist in every possible way to get this new freight for their roads.

In many parts of Europe there are buyers who purchase the straw and do the retting themselves, and this is part of the present plan in the United States, and is the only method by which uniformity in the retting of fibre can be obtained.

The lowest priced flax on the market is Russian, which brings 23 cents per pound, and the best is Belgian, which brings 33 cents per pound. It is conservative to claim that the new method flax will bring an average price between these two, which is 28 cents per pound. The margin between the cost of production (three-and-one-half cents per pound) and the selling price is so great that the costs can be multiplied and still be much below cotton, hemp or manilla, and being a superior fibre to any of these, flax will undoubtedly displace them for many uses.

GEORGE A. LOWRY.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 14.. Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Brewing, Institution of, at Charing Cross Station Hotel Strand, W.C. 7.30 p.m. Annual General Meeting. Mr. James Stewart, "The Malting Barleys of 1928."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Major A. Jenkin, "Electric Trolley Omnibuses."

Engineers Society of, Burlington House, W. 6 p.m. 1)

Major E. Scott-Snell, "The Vacuum Power Oil Lamp." (2) Mr. Charles Scott-Snell, "Neu-Flame."

Geographical Society, at Lowther Lodge, Kensington Gore, S.W. 5 p.m. Colonel Sir Gerald Lenox-Conyngham, "The Cambridge Pendulums for Gravity Survey."

Heating and Ventilating Engineers, at the Borough Polytechnic, Southwark, S.E. 7.30 p.m. Mr. A. T. Henly, "Timber Drying and Seasoning."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. A. Spittle, "Recent Developments in the Manufacture of Condenser Tubes."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture V—The Alps."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Brig.-General F. D. Hammond, "Some Transport Problems of the Empire."

TUESDAY, JANUARY 15..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Prof. Dr. R. Ruggles Gates, "Studies of Eskimos and Indians in the Canadian Arctic."

Architects, Royal Institute of British, 9, Conduit Street, W. 5.30 p.m. Mr. H. V. Lanchester, "The Development of South London."

Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. Mr. D. Harcourt Kitchin, "The Bega Races of the Eastern Sudan."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."

At the Technical College, Derby. 6.45 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as applied to Steam Generation."

Mechanical Engineers, Institution of, at the Royal Metal Exchange, Swansea. 6.30 p.m. Mr. J. W. Burr, "The Electrification of a Small Railway."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. R. Dowson, "Some Aspects of Steam Turbine Development and Application."

Philosophical Studies, British Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. Mr. Roger Fry, "Representation in Art."

Royal Empire Society, Northumberland Avenue, W.C.2. 8.30 p.m. Sir Burton Chadwick, M.P., "Seamen and the Empire."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. F. A. Freeth, "Critical Phenomena in Saturated Solutions."

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Discussion on the Presidential Address on "The National Income," to be opened by Prof. A. L. Bowley.

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. A. E. Sewell, "The Development of New Traffic by Transport Undertakings."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. J. H. Stirk, "Some Impressions of Transport in Canada."

University of London, at Bedford College for Women, Regent's Park, N.W. 10 a.m. Miss Johnson, "The Arthurian Legend in France."

WEDNESDAY, JANUARY 16..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. H. Dalrymple-Hay, "Merits and Demerits of Alternative Methods of Taking Water for modern Power Stations from Tidal Waters."

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr. T. W. Sampson, "The Electrical Engineer and Medical Science."

Fuel, Institute of, at Burlington House, W. 6 p.m. Messrs. Berg and Erich Vogt, "Continental Experience in Pulverised Fuel Practice."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Annual General Meeting. Sir Richard Gregory, Presidential Address, "Amateurs as Pioneers."

Microscopical Society, 20, Hanover Square, W. 8 p.m. Annual General Meeting. Presidential Address by Mr. Joseph E. Barnard, "Some Aspects of Ultra-Violet Microscopy."

North-End Coast Institution of Engineers and Shipbuilders, Belbec Hall, Newcastle-on-Tyne. 7.15 p.m. Messrs. H. Caird and W. S. Paulin, "Steam Engine Machinery versus Diesel Machinery."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture VI—The Alps (continued)."

United Service Institution, Whitehall, S.W. 3 p.m. Wing-Commander A. G. R. Garrod, "Auxiliary Air Force and University Air Squadrons."

University of London, at Bedford College for Women, Regent's Park, N.W. 3 p.m. Prof. Dr. Spurgeon, "Wordsworth and Coleridge."

THURSDAY, JANUARY 17..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. A. H. Dickins, W. E. Hugh and G. A. R. Kon, "The Chemistry of the Three-carbon System. Part XX: Cyclopentylideneacetone and Cyclopentylidenemethylethyl ketone." (2) Mr. H. D. K. Drew, "Non-existence of Isomerism among the Dialkyl Telluronium Dihalides." (3) Messrs. C. S. Gibson and J. L. Simonsen, "Indian Turpentine from Pinus Longifolia Roxb. Part V: The Oxidation of d-Δ^3-carene with Beckmann's Chromic Acid Mixture."

Linnean Society, Burlington House, W. 5 p.m.

Mechanical Engineers, Institution of, at the Queens' Hotel, Birmingham. 6.30 p.m. Annual Meeting.

At the Engineers' Club, Manchester. 7.15 p.m. Dr. E. G. Ritchie, "Steam Storage."

At the Hotel Metropole, Leeds. 7.30 p.m. Dr. H. W. Swift, "Power Transmission by Belts: An Investigation of Fundamentals."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. A. J. Dale, "Refractories for use in Metallurgical Furnaces."

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m.

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr. Gordon Home, "Roman London."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. I. de Bruyn, "Rembrandt Etchings."

FRIDAY, JANUARY 18..Chemical Engineers, Institution of at the Institution of Civil Engineers, Great George Street, S.W. 6.30 p.m. Prof. John W. Cobb, "The Reactivities of Solid Carbon in Fuel Processes."

Dyers and Colourists, Society of, at Milton Hall, Manchester. 7.30 p.m. Dr. S. G. Barker, "The Standardisation of Fastness of Dyestuffs on Dyed Fabrics."

Electrical Development Association, British, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. C. H. Rayner, "Electric Heating and Cooking Developments."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. Foster Petree, "Notes on the Fitting and Operation of Michell Bearings."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Captain F. W. Cable, "Some Notes on the Collection of London Refuse."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. J. G. Weir, "Modern Feed-Water Circuits."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir William Bragg, "Further Progress in Crystal Analysis."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture VII: The Alps (continued)."

University of London, at Kings College, Strand, W.C. 5.30 p.m. The Rev. Principal John Oman, D.D., "The Study of Religion—Lecture II. Method."

SATURDAY, JANUARY 19..Geologists' Association, at the Museum of Practical Geology, Jermyn Street, S.W. 2.30 p.m. Dr. R. Crookall, "Coals, their Composition and Origin."

L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. D. Martin Roberts, "London through the Ages."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Monsieur E. Cammaerts, "Flemish and Belgian Art—The Portrait."

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FRIDAY, JANUARY 18th, 1929.

All communications for the Society should be addressed to the Society, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 21st, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture I.)

WEDNESDAY, JANUARY 23rd, at 8 p.m. (Ordinary Meeting.) SIR HENRY A. MIERS, D.Sc., LL.D., F.R.S., "Museums and Education." THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

DR. MANN JUVENILE LECTURES.

The second of the two juvenile lectures annually given under the Dr. Mann Trust was delivered on the afternoon of Thursday, January 10th, by CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House.

In this lecture Sir Arthur Clarke told the story of Lighthouses, which he described as "the street lamps of the sea—the street corner lamps that light the sailor at the beginning and end of his voyage, outward and homeward bound." He said that the cost of the upkeep of lighthouses, light-vessels, buoys and beacons round the coasts was about £1,000,000 per annum, and showed a number of lantern slides illustrating the different types of lighthouses which have existed at various times, from the Pharos of Alexandria, one of the seven wonders of the ancient world, and the Pharos of Dover, called Cæsar's tower and said to have been built by the Romans, down to the Eddystone Lighthouse of the present day. Sir Arthur then showed a number of slides illustrating the historical development of methods of illumination—beacon fires of wood and coal, candles, paraffin lanterns, incandescent petroleum, and finally electric light. He also referred to the numerous

modern devices now available for securing the automatic operation of the lights, and concluded with some remarks on directional wireless, which, he said, might be destined to the most potent factor of all for the protection of life and property at sea.

At the conclusion of the lecture a vote of thanks to Captain Sir Arthur Clarke was proposed by the Secretary, Mr. G. K. Menzies, and passed unanimously.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

WEDNESDAY, 12th DECEMBER, 1928.

SIR OLIVER J. LODGE, M.A., LL.D., D.Sc., F.R.S., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Mr. Blake knew more about electro-therapeutics than, at any rate, himself, and, he supposed, more than most of the audience did. He was very glad to take the Chair that evening at the request of the Royal Society of Arts, although, really, he had no right to do so when Sir Charles Parsons and Mr. Campbell Swinton were available.

The following paper was then read:—

APPLICATIONS OF ELECTRICITY TO MEDICAL PRACTICE.

By G. G. BLAKE, M.I.E.E., F.Inst.P.,

Hon. Radiographer in charge of X-Ray Department, Star and Garter Home for Disabled Sailors and Soldiers, Richmond.

In the first place I would like to say that the presence of Sir Oliver Lodge in the chair this evening makes this occasion one of the proudest moments of my life, and as far as the subject itself is concerned it would not be possible to have a more fitting Chairman. We all owe to him a great debt of gratitude for the part he took in sowing the seed from which has grown the tree of modern electro-therapeutic knowledge with its numerous branches. Since I received an invitation from your Society to deliver a lecture on "Applications of Electricity to Medical Practice," I have found some difficulty in deciding just how much could be included. The subject is so extensive that to deal with it adequately a whole series of lectures would be required. It is, therefore, my intention this evening to speak to you about some of those aspects of the subject which have come most closely within my own ken. The practice of electro-therapeutics is quite in its infancy, though the applications of electricity to medicine are now extending rapidly in every direction.

Prior to 1904 the medical profession made very little use of electricity; but at that date, at the invitation of the Dean of the Medical Faculty, Sir Oliver Lodge delivered a series of lectures at Birmingham University upon "Physics applied to Medicine."[1] In his opening lecture Sir Oliver used these words: "Electricity has not had a very good name hitherto in medicine; its application has been attempted, but apparently only with a modified success." Looking back over the 24 years which have since elapsed we can see what a great impetus Sir Oliver then gave to electro-therapeutics by his masterly series of lectures.

Since I commenced practice in 1905 (one year later) as one of the small band of pioneer radiographers and electro-therapeutists (the word radiologist had not then been coined) great developments have taken place. The lay radiographer in those days bridged the gap between the engineer and inventor on the one hand and the general practitioner on the other. Those of us who commenced practice, undertaking only to receive patients referred to us by qualified medical men, were readily supported. In many instances we introduced the use of X-Rays and modern electrical treatments to the local doctors and hospitals, supplying the electrical knowledge which they lacked, while they on their side supplied the medical knowledge which we did not profess.

In 1905, beyond the X-Rays (which were at that time mainly a show thing of great interest to medical men, many of whom had never witnessed their application), electro-medical treatments were little known or used by local doctors. Some of the most progressive practitioners made use of Faradic currents, and interrupted constant currents, in the treatment of paralysis, relief of pain, etc. Electrically produced radiant heat was occasionally prescribed in cases of rheumatism, arthritis, neuritis, sciatica, lumbago, etc. They would also occasionally refer cases to us for the destruction of nævi, moles, etc., by electrolysis. Electrically heated cautery was also in use. Then again static electricity from influence or frictional machines was also occasionally employed by some of the general practitioners; within a radius of 10 miles from my treatment rooms I know of two such instances where the doctors had their own static machines. High-frequency currents were also just coming under the notice of the local medical men; brush discharge or effleuve was applied from powerful resonators (the treatment in a weaker form was not then to be found under a misnomer as "violet rays" at every hairdresser's establishment). At that date very few local installations were available, and patients had to be referred to cities and large towns for treatment. From high-frequency, owing mainly to the inventions and advances made in its application to radio telegraphy and telephony, diathermy treatment was evolved by Nagelschmidt in 1907, and for many years these currents were obtained either from hydrogen arc, or quenched spark generators; but

1. Archives of Röntgen Ray, Vol. VIII. 1904.

recently with the advent of thermionic valves, a new and more potent source of supply has become available. High frequency sparks[2] have been applied by surgeons since 1905 for fulguration or the destruction of morbid tissue. With the advent of diathermy currents[3] it was found that a scalpel or surgical knife, if suitably connected to a diathermy apparatus, would cut bloodlessly; this treatment has been called "cold cautery" (as the cutting blade remains practically cold) to distinguish it from cautery by means of a red-hot cautery needle. Recently it has been renamed "endothermy," a name which connects it in one's mind with diathermy, and completely distinguishes it from a form of cautery by means of carbon dioxide snow, which is much in use nowadays.

ULTRA-VIOLET RAYS.

As long ago as 1893 Finsen, of Copenhagen, commenced to treat cases of lupus by the sun's rays and ultra violet light. A very powerful Finsen lamp was installed in the London Hospital in 1900, a gift of Her Majesty Queen Alexandra. At this time, although it was realised that the remarkable cures were due to ultra-violet radiations, the applications were locally applied.

In 1916 Simpson (an electrical engineer) devised a lamp which consisted of an arc between two Wolfram (an ore containing tungsten) electrodes. He opened a clinic in Victoria Street, where he successfully cured large mumbers of cases of various diseases. Fortunately his achievements were boomed in the Press and made widely known; I well remember discussions which took place at the meetings of the Röntgen Society, and the interest that was shown. A new impetus was thereby given to the employment of ultra-violet rays as a curative agent, and Simpson's original arc was quickly followed by the Tungsten arc, the Mercury vapour lamp, and other forms of ultra-violet apparatus at present in use for actino-therapy (artificial sunlight treatment). Since whole body irradiation has been in vogue, I have seen some truly wonderful cures in my own experience, of children suffering from tuberculosis, rickets, anæmia, etc. I consider the results so startling that if only the beneficial effects of occasional general treatment by ultra-violet rays could be made more widely known, I believe in a few years every home where an electricity supply is available would have a lamp installed and artificial sunlight baths would become as customary as ordinary bathing. The place for irradiation by ultra-violet rays is not a cold bathroom as I have seen suggested,

2. See Tousey's description of an electrode for application of H.F. sparks for their destructive effect, before the American Electro-therapeutic Association in 1905; also Keating Hart's method employing H.F. sparks for cancer (Archives d'Electricité Medicale, August 10th, 1907).

3. During the War the lecturer suggested and worked out a method of sterilizing fragments of shrapnel, while still embedded in the patient, by means of eddy currents, the principle being similar to that employed in the modern high-frequency induction furnace. See "The production of Diathermy Currents," by G. G. Blake, Journal of the Wireless Society of London, Vol. II, November, 1921.

but a warm sitting-room, or a bedroom, where the treatment can be had in warmth and comfort before retiring. With reasonable care the treatment is a very harmless one; its administration only requires a little common sense. An over exposure will produce an erythema (inflammation of the skin accompanied by soreness) similar to the familiar sunburn so prevalent at the seaside at holiday time. It is absolutely essential to protect the eyes from the rays; the usual method is to wear dark glasses tested for their opacity to the ultra-violet rays. It is also necessary to screen the back of the head and neck from the rays to avoid sunstroke; this can, of course, be done by wearing a suitable head covering. If not over indulged in the treatments produce a feeling of exhilaration and wellbeing which it is difficult to describe; I have often experienced it myself. On the other hand, a too frequent exposure to the rays will tend to produce the reverse effect, and cause a feeling of lassitude. This should be taken as nature's warning to abstain for a few weeks, after which the treatments can be resumed.

THE LOCAL APPLICATION OF ULTRA-VIOLET RADIATIONS.

As already mentioned, Finsen's earliest applications of ultra-violet rays were for local treatment; he concentrated the rays from a powerful arc lamp by means of a system of water-cooled quartz lenses upon the diseased area. The curative effects were accelerated by pressing the lenses against the part under treatment to render it anæmic.

It was soon shown by Bang[4] that the substitution of water-cooled iron electrodes for carbons greatly increased the yield of ultra-violet, and these water-cooled arcs could be run much more economically as regards current consumption.

In Germany at about this time[5] Görl introduced a new type of lamp for local treatment; instead of using an arc he employed a spark discharge from a condenser between spherical iron electrodes.

In 1906 Prof. Kromeyer, of Berlin,[6] devised a mercury vapour lamp made of quartz (very similar lamps made of glass had already been devised by Cooper Hewitt for purposes of illumination). These new quartz lamps were specially suited for therapeutic purposes as they permitted the short ultra-violet rays to pass which glass would have absorbed.

In 1924, while preparing a lecture on Photophony[7] for the Radio Society of Great Britain, I received the speech-laden beam of light by aid of a Parabolic mirror; the light thus collected was focussed upon one end (optically polished)

4. Medical Electricity and Röntgen Rays, by S. Tousey. Published by W. B. Saunders and Co.

5. Medical Electricity and Röntgen Rays, by S. Tousey. Published by W. B. Saunders and Co.

6. Münch. Med. Woch., 1906. No.10. P. 577.

7. Experimental Wireless and Wireless Engineer, Vol. II, June, 1925. Pp. 561-572.

of a curved glass rod; the latter conveyed it longitudinally to its far end (also optically polished), whence the light was projected on to a selenium cell. The rod not only conveyed the light round the bend, but incidentally acted as an efficient heat filter and kept the cell cool.[8]

[This was illustrated by a lantern slide].

Finding this scheme quite successful, the idea occurred to me that similar use might be made of solid quartz rods for the conveyance of ultra-violet radiations round bends, to otherwise inaccessible parts of the body, and I took out a provisional patent to cover this idea in March, 1925[9], but foolishly I did nothing further with it. Recently I have made enquiries and I find that Zilz and Seidel were already using quartz applicators in Germany.

[At this point, by means of a specially devised apparatus[10] the lecturer demonstrated the simultaneous production of many widely differing wave-lengths in the ether, viz.:—ultra-violet, the visible spectrum, heat radiations, and Hertzian waves, as employed for wireless, thus showing that all these apparently disconnected phenomena are in reality vibrations in the ether differing only in their frequencies.

A demonstration was also given of the transmission of ultra-violet rays from end to end of a semi-circular rod of quartz.

A photograph of a still life group was shown as taken by the visible light from a tungsten arc. Other photographs of the same group were shown taken in the dark by ultra-violet rays[11] only, the visible rays being screened out by a filter of special glass made by Messrs. Chance Bros., of Birmingham].

The Measurement of Ultra-Violet Rays for Therapeutic Purposes.

Several methods have been suggested:—

(1) By noting the changes of tint of pastilles coloured with methyl blue (or other chemical affected by the Rays) when used in a similar manner to that in which Sabouraud pastilles are employed for measuring doses of X-Rays.

(2) Messrs. H. D. Griffith and J. S. Taylor have suggested the use of a photo-electric cell in conjunction with an electroscope.[12]

(3) A couple of years ago I suggested that a photo-electric cell might be connected to the grid of a triode thermionic valve, and used to control the plate current. The readings of a milliampere meter in the plate circuit would give us a measurement of the amount of ionization produced within the cell by the ultra-violet radiations.

8. Patent application, 6691/25.

9. Patent application, 5801/25.

10. Experimental Wireless and Wireless Engineer, June, 1925. G. G. Blake, "Communication on Wave-lengths other than those in general use." Lecture before the Radio Society of Great Britain, at I.E.E., April 22nd, 1925.

11. Experimental Wireless and the Wireless Engineer, June, 1925. G. G. Blake, "Communications on Wave-lengths other than those in general use." Lecture before the Radio Society of Great Britain at the I.E.E., April 22nd, 1925.

12. H. D. Griffiths and J. S. Taylor, "The Cadmium Photo-electric Cell for measuring Ultra-Violet Radiation," Modern Sunlight, Vol. I, May, 1926, p. 32.

THE DETECTION OF RINGWORM BY ULTRA-VIOLET RAYS.

One of the latest uses we are making of ultra-violet rays is to enable us to detect the presence of tinea (ringworm), by noting its characteristic fluorescence. These examinations are carried out in the dark and all the visible rays are excluded by means of "Chance glass" or other suitable filters.

[The characteristic fluorescence of various substances by ultra-violet irradiation was then demonstrated].

I have often been asked which source of ultra-violet is the most suitable for therapeutic purposes, the tungsten arc, the flame arc, or the quartz mercury vapour lamp?

Each lamp has its own merits and disadvantages. The tungsten arc is probably the richest source of those wave-lengths which are required, i.e., those between 2,360 and 4,000 Angström units, which penetrate to the deep epidermic cells and are absorbed.[13]

In common with all other unenclosed arc lamps, it has also a great advantage in that there is no window between the patient and the source of radiation, so that all the wave-lengths that are able to penetrate the intervening air reach the skin; the lamp is also just as efficient when old as when new. Its drawbacks are the necessity to keep the tungsten electrodes clean and free of tungsten oxide and the fact that as the arc burns it emits a vapour of tungsten oxide, but as this vapour has been recommended for inhalation for certain diseases of the chest, it is apparently harmless.

The flame arc, though not nearly so rich in the shorter wave-lengths, gives possibly a nearer resemblance to the sun's rays, but to be effective it requires far more current and much longer exposures.

The mercury vapour lamp needs far less attention than an unenclosed arc. When new, it is nearly, if not quite, equal to a tungsten arc in the emission of the shorter wave-lengths, but it has the great disadvantage that the quartz enclosing the mercury vapour gradually becomes in use less transparent to the shorter wave-lengths. At first this can be compensated for by increasing the length of the exposures, but increased use more rapidly ages the tube, and after a life of between 1,000 and 1,200 hours it is necessary to employ a new lamp; by this time it will have lost about 40% of its efficiency. This is not due simply to a gradual diminution of the brilliance of the whole spectrum. As the lamp ages the shorter wave-lengths towards the lower end of the spectrum are filtered right out to an increasing extent.

Taking all these points into consideration, I personally prefer the tungsten arc. Until recently the latter had one serious disadvantage, i.e., though it worked admirably from a direct current supply, it was impossible to strike an arc between tungsten electrodes when the supply was A.C. or even rectified A.C. In order to try and overcome this difficulty carbon electrodes cored

13. Ultra Violet Rays in the Treatment and Cure of Disease," by Percy Hall. Published by Wm. Heinemann, Ltd.

with tungsten were employed, but in my opinion they are not nearly so efficient as pure tungsten. Recently the Medical Supply Association (London) has placed a special rectifier on the market[14] by means of which the difficulty is entirely overcome, and it is now possible to use a tungsten arc from either A.C. or D.C. supply.

[A tungsten arc, kindly lent by the Medical Supply Association, Gray's Inn Road, was then shown working from an alternating current supply. It was also demonstrated that in the absence of this apparatus a tungsten arc cannot be struck or maintained on an A.C. or a rectified A.C. supply].

IONIC MEDICATION.

I make no serious attempt in this paper to trace the various types of treatment to their earliest applications. According to James Morton,[15] the first claim of the transportation of medicines into the body by electricity was made by Pirvati, of Venice, in 1747, but according to this author small credence is to be placed on this claim. He attributes the first credible researches to G. Weidemann in 1853; little was heard, however, of this form of medication after this for many years. In 1889 a paper by Newman Lawrence and A. Harris was read before the Society of Arts on their "Cataphoric Method of Medication," and in 1890 Thomas A. Edison read a paper at the International Congress held in Berlin. He claimed that he had been able to reduce the size of enlarged joints in a gouty subject by conveying lithium into the body by aid of an electric current. He placed one hand of the patient in a dish of saline solution, and the other hand in a solution of lithium chloride. The two solutions were then connected to the poles of a C.C. battery making the lithium positive, and the saline solution negative. After treatment he showed the presence of lithium in the urine. These experiments were conclusive, and since that date much work has been done on the subject. This form of treatment is now freely prescribed by the medical profession; it is in fact one of the most commonly used forms of electrical treatment.

Newman Lawrence and Harris were probably the first to employ the term "Cataphoric medication." Since then many other names have been employed, such as, "Cataphoresis," "electrical osmosis," "ionic medication," and "ionization." These terms are frequently misused. "Cataphoresis or electrical osmosis" is a phenomenon which accompanies ionic medication, but is really a different process; it indicates the actual transfer of liquids through the pores of the skin under the action of an applied electro-motive force. Personally, I believe it may be due to alteration of surface tension and electro-capillary action through the pores of the skin (the same phenomenon that is made use of in the Lippmann capillary voltmeter).

14. British Patent No. 279,680/27.

15. See "Cataphoresis as applied in Medical Surgery and Dentistry," by James Morton. Published by Swan, Sonnenchein & Co., in 1898.

Ionization implies the transference of "ions" under the application of an electro-motive force, but does not indicate the actual transfer of the whole solution.

The two terms are, I am afraid, often used indiscriminately in medical prescriptions. It is also an understood thing that the electro-therapeutist shall discern between anions and cations (positive and negative ions) and employ the correct polarity when treating patients by ionization.

One could easily fill an evening enumerating the various ways in which electricity is now used in medicine. There is the Leduc current (a type of interrupted constant current in which the duration of the make and break are under accurate control, and in which the relationship between them can be altered at will). There is electrically produced vibratory massage. Powerful magnets are employed for the removal of fragments of steel or iron from the eye. I have such a magnet which I have on occasion used at the local hospital. Magnets are also used for the detection and location of fragments of shrapnel, etc., by noting the quivering of the tissues when a magnet fed by alternating currents of low periodicity is held in the vicinity of the foreign body, of which the depth and position can thus be judged.

Another instrument for the detection of foreign bodies is the electric probe, which, in conjunction with a telephone, makes a sound when it comes into contact with the foreign body.

Electric lights are employed in numerous instruments, for the testing of sight, transillumination, etc. One has frequently to transilluminate the antrum when X-raying the teeth to detect the presence or otherwise of pus. There are various endoscopes employed for internal examinations, the examination of the bladder, etc. Operating theatres are now illuminated in such a manner that no shadows are present to impede the surgeon during operation, this desirable result being achieved by means of mirrors. Then there is the Bergonié treatment for the heart, and for the reduction of obesity. The Cambridge Scientific Instrument Company has devised an instrument called the electro-cardiograph,* by means of which it is possible to demonstrate and record the human heart beats, for which purpose they employ an Einthoven string galvanometer ; they also make an apparatus called a phono-cardiograph, which records the volume and power of the sound, also its pitch and tone. This instrument enables us to settle the exact position of any sound or murmur in respect to the main events of the cycle of heart movements.

Electricity has been employed for measuring the time taken when converting thought into action.[16] I devised an apparatus for this purpose as far back as 1909.

*Commercial oscillographs have recently been employed with success for electro-cardiography by P. Fabre. *Comptes Rendus* 187, pp. 257-258, July 23rd, 1928. Their introduction into this branch of electro-medical investigation is likely to become very general, owing to their comparatively low cost of manufacture.

16. " Measuring the Time Taken in Conversion of Thought into Action," G. G. Blake. " Knowledge," Vol. VI, pages 14 and 15. January, 1909.

Method of Measuring and Recording the Human Emotions with a Thermionic Reflexometer.

In 1900 Veraguth, of Zurich, was the first to discover that a change of electrical resistance takes place in human beings as a result of emotional stimuli.[17] This action or rather reaction is known to psychologists as the psycho-galvanic reflex.

When lecturing for the Institution of Electrical Engineers at Derby in March this year, I borrowed the apparatus usually employed for this purpose, i.e., a specially constructed Wheatstone bridge and sensitive galvanometer. The apparatus performed its functions quite well, but, as I found it most difficult to keep the bridge balanced by aid of the five necessary adjustment knobs while the resistance of the patient was ever in a state of change owing to his uncontrollable emotions, I have since devised a more simple method which requires only one variable adjustment. In place of a Wheatstone bridge, a thermionic valve and circuits are employed.[18]

I am using this new arrangement for my demonstration this evening.

As I hope to show you, any sudden emotion will (after a pause of approximately two seconds) cause a sudden deflection of the moving coil of the galvanometer, due to an increase of conductivity. The amplitude of this deflection varies according to the type and intensity of the emotion and other conditions.

Response can be obtained by the reaction of the subject to a sudden noise, an electrical or other shock, the prick of a pin, a sudden threat of violence, and even to quietly spoken words which conjure up emotion due to sad or joyous memories, etc.

With this apparatus it is possible to measure the change of resistance produced by any emotion.

I have brought an amplifier, and I hope this evening not only to make this resistance change visible to you by aid of a mirror galvanometer, but (for the first time in public I believe) to render it audible to you as well.

[The foregoing applications of a thermionic reflexometer were then demonstrated].

Prideaux[19] has demonstrated the difference between the reactions of hystericals and of patients suffering from anxiety-neurosis, and Waller[17] tested a number of people and showed that the only portions of the anatomy of an ordinary individual which responded were the hands and feet. In the cases of certain spiritualistic mediums whom he tested, he discovered that they responded anywhere up either arm or leg, in addition to showing the

17. Das Psychogalvanische Reflexphenomen (Berlin 1900). See also "The Electrical Expression of Human Emotion," by A. D. Waller. Proc. Royal Institution, Vol. XXIII, 1921, pp. 283-293.

18. "The Measurement of Emotions by means of a Thermionic Reflexometer," by G. G. Blake. Electrical Review, Vol. CIII, No. 2661, pp. 882-884, Nov. 23, '28. (This paper gives details with diagrams and curves).

19. "Some Applications of the Psycho-galvanic Phenomenon," by T. H. Pear. "Discovery," Vol. V. Pages 116-119, July, 1924.

usual hand and foot responses. Of course this does not in any way prove the truth of spiritualistic beliefs, but it certainly indicates the abnormal sensibility of certain mediums who underwent the test, and it would appear according to this investigator to provide a method of distinguishing people with genuine mediumistic powers from those who can only make claim to possess them.

My own investigations have been so far mainly concerned with an endeavour to establish some standard against which all psycho-galvanic reflexes can be gauged. For this purpose I apply a series of known and gradually increasing voltages to any part of the subject other than that included in the thermionic valve circuit (I usually apply these shocks to the free hand of the subject). The resistance change due to each suddenly applied voltage stimulus is then

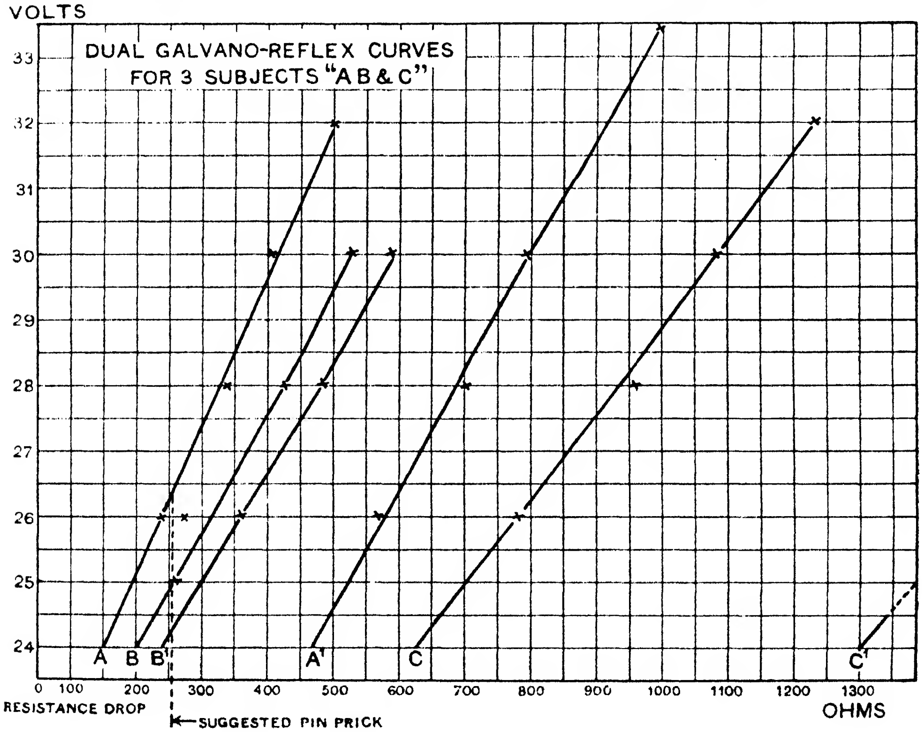


FIG. 1.

noted and curves are plotted similar to those shown at A, B, and C (Fig. 1). A^1, B^1, and C^1 are also curves of the same three subjects, and are plotted in exactly similar manner, except that whereas the shocks for curves A, B, and C were applied by an operator, those for A^1, B^1 and C^1 are self-inflicted by the subject, who in this latter case himself depressed the switch. By reference to curve A it will be seen that the mere suggestion to the subject of a pin prick (not actually applied) produced a galvano-reflex, which was equivalent to an actually applied shock of 26.4 volts. I think we can assume

therefore an equal loss of nervous energy in either case. In every case so far observed the self-inflicted shocks produced a much greater effect than did a shock at the same voltage applied by someone else. Another interesting result at once observed by a study of these curves is the great difference in the distance apart of the dual curves for various subjects. Possibly a study of these dual curves may throw light upon the relative ability of subjects to receive impressions.

After a series of emotional stimuli, the reflexes begin to tire. When this stage is reached it is useless to continue the sitting. I have no doubt, however, that an investigation of this effect would be fruitful in estimating the rapidity of nervous exhaustion. A series of stimuli (all of one voltage) could be applied to a subject at equally recurring intervals of time.

Much work requires to be done on these and similar lines and a great number of curves[20] need to be made with every variety of subject; at present I can do no more than indicate a few possible applications.

Galvano-reflex curves of neurotic patients undergoing electrical or other forms of treatment, plotted before and after treatment, might, I think, provide us with a method of estimating the improvement in their nervous conditions. It would be interesting and possibly useful to investigate the effects produced on galvano-reflexes by various drugs, such as aspirin, alcohol, etc. I am also inclined to think that a careful study of a large number of curves of patients suffering from various diseases might be of value in the study of diseases and might possibly aid diagnosis.

There is one other interesting experiment which I should like to show to you. (This is an entirely new experiment never before demonstrated).

Two subjects can be placed one in each arm of the "thermionic reflexometer."[21] If I prick one of them with a pin, the galvanometer will deflect it to the left, and if I prick the other subject, a right hand deflection takes place. If I stimulate them both suddenly by a sudden noise, a kind of emotional "tug-of-war" will occur and one or other of them will win and bring the deflection over to his side of the scale.

[An emotional "tug-of-war" was then demonstrated, and the effect was rendered both audible and visible].

Numerous experiments have been performed on the growth and development of animals and plants; in fact, there are one hundred and one other electrical applications which it would occupy too much time to describe.

Before showing you any further experiments, a short space must be devoted to X-rays, as they most certainly come well within the scope of this lecture.

20. As that portion of the galvano-reflex curve with which we are working at present forms practically a straight line, and the dual curves for each subject are found to run parallel with the A curves, it may only be necessary to apply shocks at one fixed voltage to all subjects, and then to compare the resistance drops resulting from (A) the shocks applied by an operator with (B) the fall in resistance due to self-inflicted shocks of the same value.

21. I am indebted to the Medical Supply Association for the loan of some of the apparatus we are using this evening.

There is no need for me to remind you that the medical profession is indebted to a very large extent to the late Sir William Crookes, whose early researches led to the discovery of X-rays by Prof. Röntgen in 1895. The discovery, which the latter communicated to the Physico-Medical Society of Würzburg, Bavaria, in the November of that year was to the effect that some crystals of barium platino-cyanide were placed near by a vacuum tube, and that although the latter was completely covered with black paper, the crystals fluoresced under the influence of some invisible radiations. He also showed that fluorescence could still be produced even when these radiations were intercepted by such solid bodies as books, sheets of aluminium, etc.

In March, 1896, only a few months after Röntgen's discovery[22] Mr. A. A. Campbell Swinton read a paper which I believe to be the first on X-Rays delivered in this country; it was entitled "Röntgen's Photography of the Invisible," and was given before this Society under the chairmanship of the late Prof. Dewar (afterwards Sir James Dewar). Several X-ray photographs were actually taken during the lecture and shown to the audience; these were certainly some of the very earliest radiographs taken in this country.

At its conclusion Sir James characterised it as "an interesting and almost epoch-making paper," and this it has certainly proved to have been.

On that occasion, Mr. Campbell Swinton (who, I believe, has been Chairman of your Council four times), after pointing out that ordinary photographic plates as then used were not necessarily the most suitable for X-ray photography, said, "It appears to me that the sensitiveness of photographic plates to these rays might very probably be very largely increased by treating them with fluorescent substances or even by arranging a fluorescent screen to be in contact with the film during the exposure."

His suggestion has long since become an accomplished fact; I doubt if there is a radiographer or a radiologist anywhere who does not employ intensifying screens. He also made the following prediction:—"There seems every prospect by its (X-rays) means of being able to determine the extent of calcareous deposits in the internal organs of the body, malformations and diseases of the bone, etc." . . . "It may in time be possible to photograph or actually see the internal organs in operation," etc.

All these predictions have been abundantly fulfilled and it must not be overlooked that modern radiology owes its origin to those suggestions.

In 1896 Mr. Campbell Swinton modified Röntgen's design of an X-ray tube and improved the definition of X-ray photographs by the insertion of a sheet of platinum set at an oblique angle to the path of the cathode stream.

As far back as 1874, in order to display the heating effects of the cathode stream, Crookes had by the employment of a hollowed-out cathode actually brought them to a focus upon a thin sheet of platinum. This tube must have

22. Journal of the Royal Society of Arts, Vol. XLIV, March 6th, 1896.

been a powerful source of X-rays, but, unfortunately, being invisible and unexpected, they remained unnoticed.

In 1896 Professor H. Jackson constructed a tube very similar in design, but this time with special reference to the production of X-rays. It was a combination of those employed by Crookes and Swinton. He brought the cathode stream to a focus by means of a concave cathode, the anode on to which they were focussed being set at an angle of 45°. X-rays from this tube being generated from a point source, sharp shadows resulted, making it possible for the first time to obtain really clear and useful radiographs. Kaye has since shown that the output of a tube is almost independent of the angle at which the anticathode is set.[23]

Independently and during the same year Campbell Swinton and Elihu Thomson designed double cathode tubes for alternating currents.[24] Since this date many types of tube have been designed and placed on the market. Until 1913 partially exhausted gas-filled tubes held complete sway, but following the advent of the thermionic valve, invented by Professor Fleming in 1904,[25] and a large amount of research work carried out mainly at the Cavendish Laboratories at Cambridge,[26] Professor W. D. Coolidge, of Iowa, U.S.A., designed a tube[27] having a hot spiral filament as its cathode. This tube was very completely exhausted. Its outstanding feature from the radiographic point of view was that the number of electrons projected from the cathode depended upon the temperature of the latter. This tube has since come into very general use; it has many points in its favour, although it is at least four times as expensive as a good gas-filled tube.

In the hands of a practised radiographer the latter will yield equally good if not better work (I speak, of course, of the radiography of patients; it will not, I believe, compete with the Coolidge tube in the radiography of metals).

The Coolidge tube is unquestionably much less difficult to handle, and can be used by rule of thumb methods.

In 1924 another very important innovation in X-ray tube construction was achieved—I refer to the introduction of the Philips Metalix tube.[28] Its

23. See Proc. Röntgen Society, 1909, and " X-Rays," by G. W. C. Kaye, D.Sc. Longmans Green & Co.

24. " Electricity in the Service of Man," by R. Mullineux Walmsley. Cassell & Co.

25. Proc, Royal Society, London. Vol. LXXIV, page 476, 1905. Also " History of Radio Telegraphy and Telephony," by G. G. Blake. Chapman & Hall (for Edison effect and the Wehnelt hot cathode).

26. " Some Aspects of Radiology," by G. W. C. Kaye. Röntgen Journal, Vol. XVI, April, 1920.

27. Paper by W. D. Coolidge. Physical Review, Vol. II, Series II, 1913. Page 409. Also " The Measurements of Radiation from the Coolidge and other X-Ray Tubes in Clinical Use." By Sidney Russ. Röntgen Journal, Vol. XI, page 42, April, 1915.

28. Fortschritte auf dem Gebiete der Röntgenstrahlen (Kongressheft Innsbruck, 1924). Also " New Metalix Tubes for Radiography and Therapeutics," by A. W. Bouwers. (Physicist of Philips Lamp Works). British Journal of Radiology (Röntgen Society Section), page 139-143, April, 1927.

construction incorporates several new and very important features, which, in my opinion, are likely to earn for it a pre-eminence in the radiographical world.

Firstly, there is the method employed for bringing the electron stream to a focus. In lieu of a concave cathode or spirally wound filament, use is made of an electrostatic field similar in some respects to that employed in a cathode ray oscilloscope. The cathode stream passes through a negatively charged diaphragm which repels the electrons to its centre, and in this way brings them to focus upon the anode.

The development of thermionic valves for radio-telegraphy has led to much research work on the sealing of glass to metal, also methods for making metal impervious to gas molecules, so that when a metal tube is once exhausted it will retain its condition of vacuum. The Metalix tube, as its name implies, is made of metal and has a glass window sealed into one end. As the latter is the only part of the tube transparent to the X-rays, the need for heavy and cumbersome protection boxes, with which all other forms of X-ray tube have to be surrounded, is entirely dispensed with. The anode of this tube is also of unusual construction. It is set parallel with the cathode, and the cathode stream impinges against the sides of a conical hole in its centre. In this way a larger surface of metal is subjected to bombardment than would be the case were the surface flat, and as the major part of the spluttering accompanying the electronic bombardment takes place within the conical cavity the walls of the X-ray tube are shielded.

In addition to the primary function of the charged diaphragm already described, the latter performs another extremely useful purpose. It is well known that the life of the filament of an X-ray tube is considerably shortened owing to its bombardment by positive ions, which travel in the reverse direction to the cathode stream. The charged diaphragm must also act as a screen against this effect.

I am hoping that X-ray tube manufacturers will be able to borrow one more idea from the radio engineers, and that they will soon supply us with X-ray tubes fitted with dull emission filaments. Lack of time makes it quite impossible this evening to touch on X-ray coils, interrupters (electrolytic, arc, or mechanical), high tension transformers, screens fluorescent, or intensifying, the Potter-Bucky diaphragm,[29] the radiography of the gall-bladder by aid of iodeikon, etc.

The first radiographs were taken by Röntgen in 1895, when he obtained shadows of metal objects inside a wooden box, and also outlines of the bones of the hand. Even at that date the great possibilities which X-rays offered to surgery were noted by him. These new rays naturally made a great appeal to the imagination of hundreds of scientifically-minded men, both lay and medical, and following the introduction of the Jackson focus tube, X-rays

29. For description see Wilsey. The American Journal of Röntgenology, January 1922.

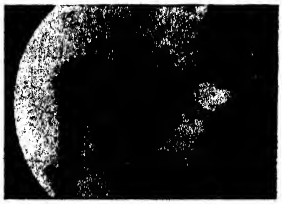
A. Barium Meal Radiograph of stomach. Arrow indicates gastric ulcer.

B. Same Patient 15 minutes later. Note Barium still retained at point of ulceration. A quantity of the meal is now in small intestine.

C. Same Patient 24 hours after intake of meal. Showing sagging of transverse colon with sharp kink at hepatic flexure.

D. A Patient suffering from a malignant growth which almost completely obstructs the passage of the meal.

E. A tooth in right antrum.



F. A fractured clavicle.

G. Diverticulum of oesophagus.

H.—Lateral view of dorsal vertebrae.

Dental Radiographs.

I. Unerupted and misplaced canines.

J. Four lower incisors. Note focal abscesses.

K. Plastic radiograph of needle in hand.

FIG. 2.

soon found a recognised place in surgery. Examples of radiographs from my own practice are given in Fig. 2. The plastic radiograph " K " is made in a special manner and is the result of a combination between a positive and a negative picture.

STEREOSCOPIC RADIOGRAPHY AND LOCALIZATION.

In 1896 Elihu Thomson pointed out that stereoscopic radiography could be achieved if the X-ray tube was displaced a distance of about 2½in. for the second exposure, and that such radiographs should be of great value to surgeons in the location of foreign bodies.

One of the first to make use of his suggestion in this country was the late Sir James Mackenzie Davidson, who not only worked out a practical method of making such radiographs and of viewing them afterwards by means of a Wheatstone stereoscope, but by applying the principles of triangulation (suggested by stereoscopy) was the first to devise a method in 1898[30] of measuring the exact depth and location of embedded foreign bodies. This is now well known as the Mackenzie Davidson cross-thread method of localisation.

Since this date many other X-ray workers have made use of very similar methods of geometric localization.[31] While most of these methods are quite satisfactory, all of them—with the exception of the very useful " Parallax " screening method—require careful preliminary notes and measurements, as to tube distances, displacements, etc. Again, they require specially designed tube-holders, fitted with tube height and displacement scales and the like. After the outbreak of the War, I was called upon to do a large amount of portable radiography at the various hospitals* to which I had been appointed radiographer. Massive tube stands were out of the question, and when asked by the surgeons to report on the localisation of fragments of shrapnel, etc., I soon found myself severely handicapped. It being impracticable to employ heavy calebrated stands for this portable work, I devised a method[32] by means of which localization can be carried out without any preliminary measurements. Any simple protective stand can be employed and no notes or measurements of the tube displacements have to be taken. Only one photographic plate is required and on this plate two exposures are made without disturbing the patient. All the necessary measurements, tube displacement, height of tube, and displacement of the shadow of the foreign body are self recorded (photographically).

The radiograph thus obtained provides a permanent record of the case from which at any time the depth of the foreign body or bodies can be ascertained either graphically by triangulation, or by the equation $X = \frac{dh}{d + L}$

where X = the depth of the foreign body
d = the displacement of its shadow on the X-ray plate,
h = the height of the tube from the plate when the exposures were made,
L = the distance that the tube was displaced between the two exposures.

30. Archives of Röntgen Ray, May, 1898. Also Proc. Royal Institution, Vol. XXI, Part III, No. 110, April, 1918, pp. 662-668.

31. For further information on the various best known methods refer to " X-Ray Observations for Foreign Bodies and their Localization," by Harold C. Gage. Published by Wm. Heinemann, 1919.

*Seven Red Cross and four civilian Hospitals.

32. Journal of Röntgen Society, Vol. XI, No. 42, January, 1915, and Vol. XII, No. 46. Also, Archives of Radiology and Electro-therapy, July, 1915. Also, Knowledge, Vol. XXXVIII, November, 1915.

Before the radiographic exposures are made a couple of small adhesive metallic plasters (say in the shape of a square and a triangle) are placed on the skin. These are arranged so as to be in contact with the plate to ensure that each of them will only cast one shadow. When the radiographer's report is handed to the surgeon in charge of the case, the latter is given a tracing on a flat sheet of celluloid upon which the positions of these two adhesive markers are indicated, together with the exact position of any foreign body or bodies relative thereto. It is then only necessary for the surgeon to move the limb or other part of the patient into the one and only position which will enable him to place the tracing in exact coincidence with the markers on the patient's skin. When this has been achieved, he knows that he has placed the patient in exactly the same position as that in which he was when the radiographic exposures were made. I have found this scheme of particular advantage as in nine cases out of ten the surgeon is not present when the localization is being made. He has now only to make incisions at the positions indicated on the tracing in order to reach the foreign bodies at the depths which he is also given.

I have further extended this method to the exact localisation of foreign bodies in the eye.[33] In this case also only one plate is employed, on which all the measurements are self-registered and recorded and the exact position of the F.B. is afterwards ascertained in three planes.

[Slides were then shown illustrating three examples of foreign bodies localized by the above method, viz. :- a needle in a hand ; an airgun bullet within an eye ; and a fragment of shrapnel in an eye. Examples illustrating the use of radiographs by Veterinary Surgeons were also shown[33]].

THE THERAPEUTIC APPLICATION OF X-RAYS.

X-rays were probably first brought into use as a therapeutic agent in 1896. The question of priority in their therapeutic application has been a much disputed one.[34]

In France Dr. Despeignes[35] reported the application of X-rays to a case of cancer of the stomach in 1896.

In 1897 Freund reported the X-ray treatment of a large hairy nævus[36] and the next year Freund and Schiff reported six similar cases successfully treated.[37]

33. Archives of Radiology and Electro-therapy, July, 1915. (When this paper was written one preliminary measurement was necessary, i.e., the distance from the centre of the bridge of the nose to the X Ray plate. This can be dispensed with by placing a small pellet of lead in that region before the exposures are made, and ascertaining its distance from the plate after development, from the displacement of its shadows by triangulation).

34. See "The Röntgen Rays in Therapeutics and Diagnosis," by Pusey & Caldwell. Published by W. B. Saunders & Co.

35. "La Semaine Médicale," July 29th, 1896. Vol. XVI, p. CXLVI.

36. Wiener Medizinische Wochenschrift, March 6th, 1897. Vol. XLVII, p. 428.

37. Wein. med. Wochens, 1898. Vol. XLVIII, p. 1058.

Another of the earliest authentic reports of X-ray treatment which I have been able to find is a report by Ravillet in 1899 of benefit in a case of tuberculous laryngitis.[38]

Out of a large number of reports which have appeared in various medical journals, it is very difficult to discover who was the first to apply X-rays to lupus. I find that a case was treated by Schiff and Freund in Germany in 1898.[39] A case was referred to me for treatment by Dr. Gardiner in 1905; (this was illustrated by lantern slides as seen before and after treatment). I believe Kümmel[40] reported a cure during 1897. In the United Kingdom, Hall Edwards[41] treated a case of lupus in 1900. The treatment of tinea (ringworm) was suggested by Freund in 1897. One application of X-rays, followed by removal of the hairs after an interval of from 15 to 21 days completes the cure, and in my experience of the treatment of hundreds of such cases during the last 22 years, I have never come across a single case in which there has not been perfect regrowth of hair. Idiosyncrasies are, however, stated to exist.

The earliest case of the treatment of cutaneous carcinoma by X-rays was (according to Pusey) a rodent ulcer treated by Stenbeck[42] of Stockholm, and demonstrated by him in December, 1899.

The foregoing are undoubtedly some of the very earliest applications of X-rays for their curative influence, and I do not intend to extend the list any further this evening. Had there been time I should have liked to have shown you how the technique has developed since these first therapeutic applications, until to-day both here in England and more particularly in Germany at Erlangen and in France deep therapy with very hard tubes is being administered.

In 1908 Barkla and Sadler showed that when a beam of heterogeneous X-rays falls upon a sheet of metal, the latter becomes the source of a new supply of X-rays, homogeneous in character, and that the penetrating power of their characteristic radiations is dependent upon the atomic weight of the element from which they are emitted.

This discovery has been applied to the treatment of rodent ulcer by several workers. I have myself treated one such case for a local hospital, by the application of zinc ointment just before the application of X-rays.

The ulcer healed up quite nicely, but in the absence of further experience with other similarly treated cases, I am not prepared to express an opinion as to whether the presence of the zinc accelerated the cure. I have healed up many other rodent ulcers quite as rapidly with X-rays alone.

38. Ruvue de la Tuberculose, April, 1897.

39. Wien. med. Wochens. Vol. XLVIII, p. 1058. 1898.

40. At the 22nd Congress of the Duetsche Gesellschaft für Chirurgie. April 22nd, 1897.

41. Edinburgh Medical Journal, Vol. XLIX, 1900, p. 139.

42. "The Röntgen Rays in Therapeutics and Diagnosis," by Pusey and Caldwell. Saunders & Co.

Rodent ulcers have been healed up by several workers by the introduction of zinc ions by ionization.

I suggest that probably a more rapid treatment for rodent ulcer should lie in a blend of these two treatments, i.e., first to introduce the zinc ions as deeply as possible into the ulcer and the surrounding tissues, and then to apply X-rays in order to bring out their characteristic radiations.

As far back as 1900 Curie and Sagnac showed that the absorption of X-rays by an element is accompanied by the liberation of electrons; this electronic emission reaches a maximum when characteristic radiations are excited. This fact was brought very forcibly to my notice in 1918 when Professor E. A. Owen and myself carried out some experiments in connection with a research he was making on this very subject.[43]

According to Professor Bragg, X-rays themselves are ineffective, and all the chemical and physical changes observable under their influence are to be attributed to the electrons they produce when they are arrested.

Kaye's Postulate.

According to G. W. C. Kaye, the only purpose X-rays serve in therapeutics is to plant the action deeper in the body. He says : " To produce therapeutic action at any particular point, there must first of all be transformation of the X-rays into corpuscular rays (electrons), and then absorption of these corpuscular rays."

Only 23 years after the discovery of X-rays, their medical application had grown to such proportions that in his presidential address to the Röntgen Society in June, 1918, Dr. Kaye made the following statement :—" But the all-important use of the X-rays, and the one most dominant in our minds to-night, is their medical application. Every hospital of any size now has its X-ray department, and there are many thousands of radiologists, both medical and laymen, devoting their lives to the work, and by their aid miracles are literally being wrought daily."

The photographs, shown in Fig. 3, illustrate a few of the cases which have been referred to me for X-ray treatment by hospitals and doctors during the course of my practice.

[Lantern slides of a number of other cures of lupus, rodent ulcer, epithelioma, etc., were shown].

Quantitative X-ray Measurements.

Several methods have been evolved for more or less accurately measuring the dosage of X-rays, but time will not permit me to enumerate them all. The two outstanding methods now in use are (1) the platino-cyanide of barium colour change method, and (2) the method of measuring the ionization produced

43. See "The Asymmetrical Distribution of Corpuscular Radiations produced by X-Rays." By E. A. Owen. Proc. Physical Society of London. Vol. XXX, Part III. April 15th, 1918.

Epithelioma.

Nov. 1st. Cured Jan. 19th.

Rodent Ulcer.

Before Treatment. During. After. 11 years after.

Angiomatous Tumour.

Naevus.

Jan. 6th. Feb. 12th.

Papilloma.

Fig. 3.

by X-rays within an ionization chamber by observing the discharge of an electroscope.

Quite recently another method has been invented in Austria at the Strauss Laboratories, Vienna, which makes use of a triode thermionic valve.

The grid of the valve is charged negatively by means of a small transformer ; in this condition no current can pass through its plate circuit. An ionization chamber is connected to the grid, which in use acts in similar manner to the grid leak so familiar in radio reception. When the ionization chamber is irradiated, the grid begins to lose its charge more or less rapidly according to the intensity of the rays, owing to the increased conductivity of the air in the ionization chamber as it becomes ionized. As soon as the grid potential has exceeded a certain minimum positive value, an anode current passes through

the valve and operates a relay. This recharges the grid and at the same time operates a clock, a light signal, or any other auxiliary apparatus, that may be required. The process automatically and periodically repeats itself. The time taken will depend upon the amount of the "X" radiation. An exact measurement of the dose can therefore be obtained by the automatic counting of the relay movements.

The instrument has been named by the makers the "X-ray Mecapion."

THE APPLICATION OF CURRENTS OF HIGH-POTENTIAL TO THERAPEUTICS.

Static machines have been employed for therapeutic purposes since the earliest days of medical electricity. Prior to the year 1899, when W. J. Morton, of New York, introduced a new modality[44] known as the "static wave current" (often called after him "the Morton wave current") the treatments were usually either applied locally in the form of static breeze or effleuve, or generally, by charging the patient to a high potential on an insulated platform or couch.

The static breeze from the positive pole of the machine had a sedative effect, and the breeze from the negative pole was employed where stimulation was desired.

Morton's scheme consisted in placing the patient on an insulated platform, and connecting him to one pole of the static machine, the other pole of which was earthed. Under these conditions when the machine was worked the voltage applied to the patient steadily increased until the potential was sufficiently high to break down the air gap between the discharge knobs of the machine (previously set at a suitable distance apart). When this occurred the patient was momentarily discharged to earth, and a powerful but painless contraction of the muscles in the vicinity of the electrode occurred. After the discharge, the potential gradually rose again and the process was repeated ad lib. The intensity of the contractions and the time intervals between their occurrence depends mainly on the distance of the separation between the spark knobs of the machine.

This form of treatment has proved of great value, in the relief of local congestion and hyperæmia, relief of pain, muscular spasm, etc. I have seen surprisingly rapid cures of long standing sciatica, lumbago, etc. I do not, however, wish to give the impression that this treatment is a specific. We all meet with intractable cases at times, and again so much depends upon the primary cause of the trouble, but the percentage of cases that obtain lasting relief is quite high.

Probably by far the greatest boon bestowed by this treatment is the relief which it gives in cases of enlarged prostate gland. The results are truly

44. Bulletin Officiel de la Societé Française d'Electrothérapie. January, 1899. Electrical Engineer, March 4th, 1899. Transactions of the American Electrotherapeutic Association, 1900. "High-potential and High Frequency Currents," by Wm. Benham Snow. (New York Scientific Authors Publishing Co., 1905).

wonderful; in many cases relief is experienced after the first application. Ten or twelve treatments usually give comfort and allow the patient to sleep without interruption through the entire night. I have treated numbers of such cases that have been referred to me by various medical men, and most of them have obtained great relief.

The great drawback with all static modalities is the erratic behaviour of influence and frictional machines in damp weather. I overcame this drawback when in 1910 I devised a method[45] for obtaining static electricity from an induction coil for medical purposes, and also for producing painless static contractions similar to those obtained by Morton from a static machine.[46] While experimenting with this method I took a number of spark photographs[46] to show that the discharges obtained were pure negative and positive, and exactly comparable with those produced by the discharges from a Wimshurst or other type of static machine.

Illustrations A and B in Fig. 4 show respectively a positive and a negative spark photograph. As will be seen, each photograph has distinct characteristics of its own.

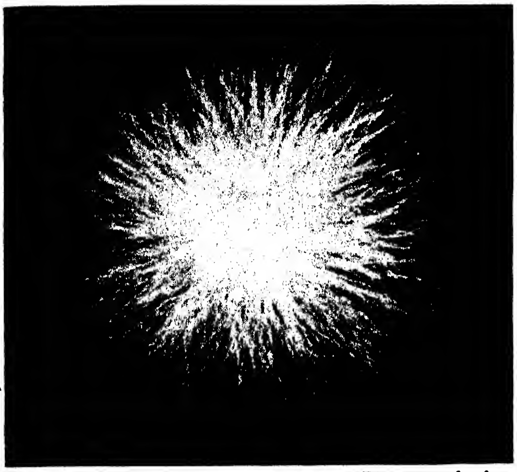
At about this date 1911 a controversy was at its height regarding the results obtained by the application of high-frequency currents. In cases of neuritis, for instance, some workers claimed relief of pain in nearly all cases treated; others obtained very erratic results, and others again, instead of finding improvement, reported that their patients seemed to get worse. The idea occurred to me to investigate the discharges from a high-frequency resonator by aid of spark photographs. Illustrations C and D in Fig. 4 show the results obtained. It will be observed that either negative or positive can be made to predominate, according to the direction in which the current is passed through the primary of the induction coil. or which of its secondary terminals are connected to which of the terminals of the high-frequency apparatus.

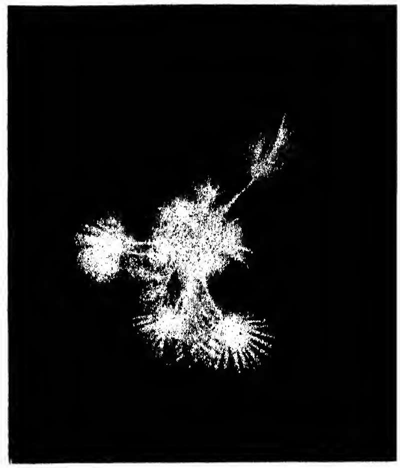
Until I pointed out this fact, connections were made quite indiscriminately from time to time, it being thought that as high-frequency alternating currents were employed, it did not matter which way the connections were made. Since conducting these experiments I have been very careful to connect for negative predominance when stimulation is required and for positive predominance for sedative effects. A distinct improvement in results has been noted.

All sorts and conditions of high-frequency resonators are now on the market, and in my opinion a careful investigation is badly needed in order to standardize

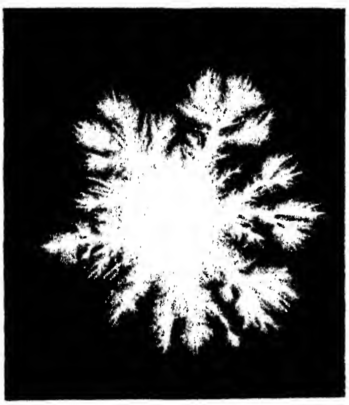
45. British Patent No. 22660/II. (Exhibited for the first time at the British Medical Exhibition at Liverpool, 1912).

46. For full details and description see "Method of obtaining Static Electricity from an Induction Coil," by G. G. Blake. Archives of Radiology and Electrotherapy, February, 1919. Numerous references re spark photographs are also given. (Recently spark photographs have been very successfully employed in Electrical Engineering for the analysis and measurement of surge voltages on transmission lines due to lightning. Everett S. Lee and C. M. Foust. General Electric Review. Vol. 30, March, 1927, Pp. 135-145. This paper also gives about a dozen references to spark photography).

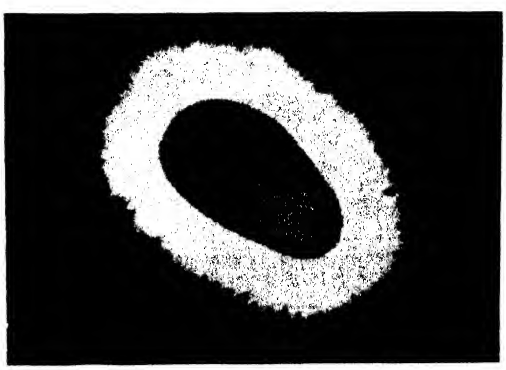




Spark Photographs from Static Machine.
A. Positive. B. Negative.



Spark Photographs from High-frequency Resonator.
C. Positive Predominating. D. Negative Predominating.



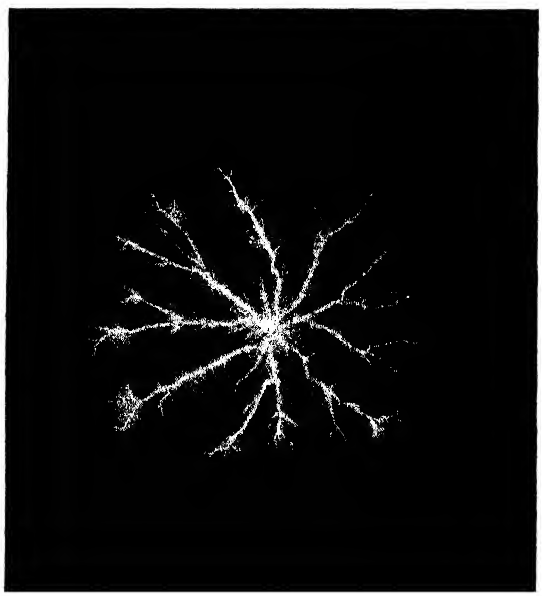
E. An Example of a Fingerprint taken by High-frequency Spark Method (suggested by Author), for Criminology.

and to make sure that the predominance (if any) shall be known and be reversible when required. Oscillographic methods could doubtless be employed in place of the somewhat clumsy spark photographs.

I have a strong feeling that most of, if not all, the therapeutic results we are obtaining are likely to be due to these peak value predominances, and that in reality we are employing our H.F. resonators mainly as a means of obtaining high-potential discharges, similar to those from a static machine. If my ideas on this matter are correct, it might be well worth while to conduct some experiments with a view to increasing the amount of predominance obtainable. I only wish I had the necessary free time and apparatus at my disposal to carry out this and many other electro-medical researches which constantly occur to me.

SPARK PHOTOGRAPHY OF THUMB PRINTS.

I have made a few experiments to see how spark photographs could be made use of in criminology for taking thumb-prints. The example shown in Fig. 4 was taken instantaneously, and shows some possibilities for spark photography in the new field thus opened.[47]



The Small "Splashes" below and on Right-hand Side of this High-Frequency Spark Photograph are due to Groups of "Ions" Projected on to the Surface of the Plate from the Atmosphere.

FIG. 5.

47. Thumb-print spark photographs were exhibited for the first time at my lecture to the East Midland Sub-centre of the I.E.E. at Derby. March 20th, 1928.

ADDENBROOKE'S METHOD OF STUDYING HIGH-TENSION DISCHARGES.

The following experiment was shown in January this year by G. L. Addenbrooke[48] at the Exhibition of the Physical and Optical Societies at South Kensington, and it provides us with another means of studying these high tension discharges.

[A view of the surface of a glass vessel filled with "castor oil" was projected on to the lantern screen. Above its centre was a pointed electrode. If the latter was given either a positive or a negative charge, ions of like sign to that of the electrode were projected on to the surface of the oil, and the splashes which they produced could be seen. As in the case of spark photographs the characteristics of the impressions for positive and negative ions were clearly defined].

In Fig. 5 I have succeeded in obtaining a photographic record (round the borders of an ordinary H.F. spark characteristic) of some of the groups of ions thrown down from the atmosphere on to the surface of the plate. It is probable that the sensations one feels from static and high-frequency brush discharges are due to the impact of showers of these ions. The last experiment was in reality an early stage of "electric wind."

I would like to have shown the modus operandi of many other electro-medical applications, but I must refrain as time will not permit.

DISCUSSION.

MR. A. A. CAMPBELL SWINTON, F.R.S., said the lecture demonstrated what a long way had been travelled in the subject in the last 32 years since he had had the pleasure of giving a lecture in the hall of the Royal Society upon Röngten rays. He was amazed at the complexity of the experiments which had been shown by the lecturer. The ground which Mr. Blake had covered was so enormous that it was really too difficult for one to fix upon any particular point to discuss. He would not delay the meeting by any further remarks, as the time was very late, but he did desire to congratulate Mr. Blake upon a very interesting and remarkable lecture, and upon the success of his wonderful experiments.

THE CHAIRMAN conveyed the thanks of the audience to Mr. Blake for his lecture and for his wonderful series of experiments, on nearly any one of which, no doubt, Mr. Blake could have spoken for an hour. Personally he had had experience of doing lecture experiments, but he had never tried to show so many, one after the other, and with such great rapidity and such perfect success, as Mr. Blake had done. Looking back over the ground which Mr. Blake had covered he was surprised that he had been able to get so much into a single lecture.

In the early days of high frequency alternating currents, he himself had used to carry out experiments, and it had been very surprising to notice how those alternating currents, if they were of sufficiently high frequency, were not felt when they passed through the body, even although the voltage was tremendous. Ordinarily if a person had 2,000 volts applied to him he would be very much damaged; he

48. "Splashes on the Surface of a Liquid Di-electric produced by a Point Electrode with Intermittent Field." G. L. Addenbrooke, Phil. Mag., May, 1927.

would feel uncomfortable even with 500 volts driving a current through the body, but high frequency alternating currents might be driven by 30,000 volts. Nevertheless, being so very rapid in frequency they did not seem to have time to do any harm. The alternation was reversed before the nerves or the tissues had time to respond. Although he said that no harm was done by passing such high frequency alternating currents through the body, he did not think it wise continually to repeat such an experiment, because some harm might be done without one knowing of it. He himself had felt lassitude after those experiments.

In his early days he had carried out some experiments in this connection with a frog's nerve muscle, and he had found that though a fraction of a volt applied to the frog's nerve by a steady current from a potentiometer made the muscle twitch; yet when he had applied an alternating current of sufficient frequency, such as one got from the discharge of a Leyden jar oscillating some millions a second, although the voltage might be sufficient to cause sparks, the frog's legs did not twitch. He had also found that if he continued that application of the unfelt high frequency current, and then again tried to stimulate it by the one volt steady current, the frog did not feel that either. The transmissibility of the nerve had been interfered with. An inhibition had been set up in that place which had been subject to the high frequency currents, so that the perturbation which would normally be transmitted to the muscle from the one volt steady current was stopped. There was no permanent damage: it recovered after an interval.

He had visited an electro-therapeutist in Vichy, who had shown him his high frequency treatment there. One method was to put a patient in a coil of wire, round which oscillating currents were sent; but the practitioner did not seem to think that it did his patients much good, and had told him that the patients seemed to benefit more if he put them on an insulating stool and drew sparks from their knees. He had thought it was a sort of auto-suggestion; for when he applied the high frequency current or alternating magnetism, the patient felt nothing, and therefore thought nothing was happening to his complaint, and that he was not getting better, but if the patient saw sparks being taken from his knee he at once thought, " Oh, this is really something like."

He had been interested in perceiving that Mr. Blake seemed to agree with the notion that it was not radiation which acted primarily. Personally he would not expect radiation to act on gross matter directly. Radiation had a tremendously high frequency. The frequency of light oscillations—even of visible light —was not to be reckoned in millions a second but in 500 million millions a second; and the frequency of the oscillations of X-rays was higher still. He would not expect those vibrations to be able to do anything direct, but it was known now that those high frequency waves were entirely competent to eject electrons and to disturb the atom. They were quite capable of beginning a sort of stimulated radio activity, which had been investigated so much medically. It might be that they were stimulating the actual nucleus of the atom—the tumble-down from uranium through new substances to radium and on to lead, where the process seemed to stop. Those things had to be borne in mind.

He thought our own vision depended upon that power of radiation. He did not think we saw by radiation directly. He doubted if it could affect the retina of the eye directly. The retina of the eye contained something from which electrons were ejected when radiation fell upon it, and those electrons, thus projected, were competent to stimulate the nerves. He expected that our nerves were stimulated by the ejected electrons rather than by the wave direct—the photo-

electric action. That, he thought, would be found to be the theory of vision and the way in which the retina acted.

He might be asked what right he had to express any opinion on physiological subjects. He had no right at all, and he wanted to guard himself by saying that no one need believe what he had said. He was merely suggesting it in the presence of an expert audience, so that if anything was wrong in what he had said it might be corrected. Sometimes suggestions even from a layman were serviceable. At any rate, it was an idea which had a good deal to be said for it. He had no doubt that other people had had the same idea.

Altogether it would be seen that the lecturer had brought forward a subject of great interest, and he was undoubtedly owed a hearty vote of thanks.

Mr. G. G. Blake said he was extremely obliged to Sir Oliver Lodge and to Mr. Campbell Swinton for their very kind remarks.

He had been most interested in the experiment of the frog's leg. He was not familiar with it, but he remembered that a frog's leg had been used to record wireless signals, after rectification by a crystal. He thought Sir Oliver's experiment in that connexion might lead to valuable research work being done.

He had also been very interested in Sir Oliver's theory with regard to Milligan's cosmic rays. The theory that those rays might be causing the breakdown of atoms and the radio-activity of radium was entirely new to him. He would like to ask Sir Oliver if it was to be taken that they might cause the breakdown of other atoms as well as those in radio-active series. Were all elements being broken down by those Milligan rays?

The Chairman replied that he thought that most of the familiar substances were stable, so that if they ever did break down and change into others they did so with extreme slowness so slowly that no one knew that it happened. Those that were known to be radio-active were all at the heavy end—so complex that they simplified themselves; but there was more than that to be said about it. Sir Ernest Rutherford had bombarded a nitrogen atom and had knocked it to pieces. It was not merely the whole atom which was hit, but the nucleus, a thing so minute that it was very difficult to hit. Cosmic rays, which were supposed to come from the nebulæ and which were penetrating our bodies and producing some effect (because they did penetrate the earth's atmosphere, 30 inches of mercury would not stop them), might be affecting the nucleus of the atoms. Whether they were affecting the nucleus of ordinary atoms as well as the radio-active, he did not know, but Rutherford had knocked a nitrogen atom to pieces. Therefore all the atoms seemed to be vulnerable if one took the right means of attacking them. Apparently all the atoms were made out of two simple ingredients, built up into architectural structures, and might be knocked down again.

Mr. G. G. Blake said there was one other thing he would like to ask Sir Oliver. He had been present at a lecture given by Mr. Paterson at the Royal Society of Arts on electric lamps, where Sir Oliver had propounded a theory with regard to the possible cause of cancer—an electrolytic theory. If Sir Oliver could say a word about that he was sure the audience would be greatly interested.

The Chairman said he had not got the matter in his mind with sufficient clearness at the moment to make it worth while for him to speak about it. It had been a sort of disease of the filaments in lamps to which Mr. Paterson had called attention.

There seemed to be a catalytic growth in the filament of the lamp. The atoms deposited material in a weak place and went back for more, and so on continuously. Mr. Paterson had traced that it was due to the presence of certain substances; he had forgotten what those substances were.

MR. G. G. BLAKE: Water.

THE CHAIRMAN said water was generally at the bottom of all chemical reactions. Water was a wonderful substance. Chemical reactions would not begin if there was no water. Professor Baker had shown that the gases which exploded, like hydrogen and chlorine, under the action of light, would not work at all if they were quite dry. Very often he himself had found that when one took great care over an experiment and got it quite perfect, it would not respond; success had been due to some slight impurity. That was the way to make discoveries. That was the way radium was discovered—by looking out for those residual effects, and discovering why things happened. If there was no water present, even hydrogen and oxygen would not combine. Professor Baker insisted that water was essential to chemical action, and that dryness stopped it. Professor Baker was called by his undergraduates "His Imperial Dryness," so keen was he on the subject. Water in the lamps—if it had been only water—had set up the disease to which Mr. Paterson had referred; and if it was excluded it did not go on. The only thing which he himself had ventured to suggest had been that cancer might be a catalytic growth. The cells misbehaved and formed structures under some catalytic action. The point, however, was too vague in his mind at the moment for him to pursue it. It was very important for people to get to the root of these diseases, and any suggestion should be tolerated as a clue to research. The audience that night had had an example of the researches which were at present going on. It was wonderful what facility for research was forthcoming when practical applications began. When applications to engineering purposes were possible things were done on a scale unattainable by the physicist alone. When applications to medicine were possible, funds were forthcoming and apparatus was made much more convenient than those amateur things which were used in a laboratory. So it was possible to give a lecture like that which had been delivered that evening and which had covered so wide a field.

The proceedings then terminated.

NOTES ON BOOKS.

CHARLES LETTS'S ENGINEERS' DIARY. Edited by J. E. Dodsworth. Charles Letts and Co., Southwark Bridge Buildings, London. Price 3*s*., or, in refillable case, 6*s*.

Messrs. Charles Letts's Engineers' Diary is one of the best diaries we have seen, not only for engineers, but for ordinary persons, since, in addition to more technical items, it contains a large quantity of general information of a kind that is useful to everybody. In addition to the diary proper, there are 32 pages of technical and general information, and also a number of blank pages for memoranda, addresses, etc. The diary is printed on thin paper and is barely more than a quarter of an inch thick, so that it may be carried in the pocket very conveniently.

THE STRUCTURE OF AN ORGANIC CRYSTAL: FISON MEMORIAL LECTURE, 1928. By Sir William Bragg, K.B.E., F.R.S., M.A., D.Sc. London: Longmans, Green & Co., Ltd. 1s. 6d. net.

In the Fison Memorial Lecture for 1928, Sir William Bragg gives an outline of the way in which X-ray methods have been used to investigate the groupings of atoms which occur in the complex crystals of organic substances.

Commencing with a description of crystalline conditions in general, and pointing out that whatever results may be obtained will probably be very largely applicable also to the liquid and vapour states, the lecturer proceeds to a very brief account of the manner in which the crystal lattice gives rise to the well-known interference phenomena in the X-ray beam, leading to regular concentrations of energy in certain definite areas, and hence to the familiar patterning on a photographic plate situated in the path of the rays.

In the case of organic substances, saving only the very simplest, the complication of the molecule is so great that the resulting pattern is too intricate to be fully interpreted in the present state of our knowledge; but even so a quantity of valuable information can be obtained. Open-chain compounds are at present more amenable than cyclic derivatives; but "the experience gained in the study of the chains, limited though it is, has increased the chance of success with the rings; indeed, good progress has been made quite recently."

It is noteworthy that the results are in entire agreement with the views of organic structure formulated long ago, from totally different trains of reasoning, by organic chemists. This is really most fortunate, as one hardly likes to think of the war which would have resulted if things had turned out otherwise; and moreover the event contains a moral for the exponents of that school of thought which takes pleasure in the idea that one has only to wait long enough in order to see the demolition of any conclusion arrived at by the scientific world.

It will not be long, however, before the X-ray methods yield something more than mere confirmation. In their present infancy they cannot be said to do much more than add a number of details to the chemist's picture; but the work is proceeding apace, and there can be little doubt that it will achieve far-reaching results in the near future.

CORRECTION.

In the penultimate line of Engineer-Captain J. C. Brand's remarks, on page 224 of the *Journal* dated January 11th, in the discussion of Sir Eustace Tennyson D'Eyncourt's Paper on "Fuel for Ships," "seven-sixths" should be read in place of "seven-sixteenths."

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 21..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Criticism by Mr. Oswald P. Milne on work submitted for Prizes and Studentships.

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. N. Platt, "Safety in Four-Wheel Braking Systems."

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m. General Discussion on "The Anticipation of Demand, and the Economic Selection, Provision and Layout of Plant with introductory papers by Captain J. M. Donaldson ("Power Systems") and Mr. J. G. Hines ("Telephone Systems").

At the University, Edmund Street, Birmingham. 7 p.m. Captain P. P. Eckersley, Lecture on "Wireless."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. J. R. Baker, "The Northern New Hebrides."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. H. R. Sketch, "Engineering Insurance."

At the Merchant Venturers' Technical College, Bristol. 7 p.m. Dr. H. J. Gough, "Recent Developments in the Study of Fatigue of Materials."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture VIII—The Alps" (*continued*).

University of London, at University College, Gower Street, W.C.1. 2 p.m. Mr. Norman H. Baynes, "The Historical Background of Hebrew Prophecy."

At University College, Gower Street, W.C.1. 4.15 p.m. Prof. L. M. Brandin, "Le Merveilleux dans la Littérature du moyen âge."

At University College, Gower Street, W.C. 5 p.m. Mr. G. P. Crowden, "Fatigue." (Lecture II.)
At University College, Gower Street, W.C.1. At 5.30 p.m. Prof. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture II.)
Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Rev. Charles Cooper, "Precious Stones of the Bible."

TUESDAY, JANUARY 22..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Messrs. J. H. Hyde and H. R. Lintern, "The Vibrations of Roads and Structures."
Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. General discussion on "The Anticipation of Demand, and the Economic Selection, Provision and Layout of Plant," with introductory papers by Captain J. M. Donaldson ("Power Systems") and Mr. J. G. Hines ("Telephone Systems").
Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, Westminster, S.W. 6.30 p.m. Dr. L. C. Martin, "Colour and its Applications."
Roman Studies, Society for the Promotion of, at Burlington House, W. 4.30 p.m. Mr. S. N. Miller, "The York Excavations of 1926-1928."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. F. A. Freeth, "Critical Phenomena in Saturated Solutions." (Lecture II.)

WEDNESDAY, JANUARY 23..Automobile Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. M. Platt, "Safety in Four-Wheel Braking Systems."
British Empire Producers' Organisation, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m. Address on Food Products of the Empire: (1) Mr. John Gilliat, "Empire Coffee Industry"; (2) Mr. Aucher Warner, "Cocoa in the British Empire."
Geological Society, Burlington House, W. 5.30 p.m. (1) Dr. A. Jowett and Prof. Dr. J. K. Charlesworth, "The Glacial Geology of the Derbyshire Dome and the Western Slopes of the Southern Pennines"; (2) Prof. Dr. J. K. Charlesworth, "The South Wales End Moraine."
Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture IX—Ancient Folder (Folded) Mountains."
United Service Institution, Whitehall, S.W. 3 p.m. Brigadier B. D. Fisher, "The Training of the Regimental Officer."
University of London (London School of Economics), at Chesham House, 136, Regent Street, W. 6 p.m. Mr. W. Sansom, "Office Routine to Ledger Posting and Balancing in a Model Office."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture I.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture I.)
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La lirica del Paradiso." (Lecture I.)
At University College, Gower Street, W.C. 5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture II.)
At University College, Gower Street, W.C.1. 5.30 p.m. Mr. J. H. Helweg, "The Renaissance Period in Danish History and Literature." (Lecture II.)
At University College, Gower Street, W.C.1. 5.30 p.m. Prof. P. Geyl, "The Historical Background: Dutch Art in its relation to Dutch Society and Civilisation."

THURSDAY, JANUARY 24..Aeronautical Society, at St. Ermin's Hotel, Westminster, S.W. 7.30 p.m. Informal Discussion on "The Compression Ignition Engine for Aircraft: Wing-Commander G. B. Ayres ("Compression Ignition Engine") and Captain G. S. Wilkinson ("Petrol Engine.").
Antiquaries, Society of, Burlington House, W. 8.30 p.m.
Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr. Gordon Home, "Roman London." (Lecture II.)
University of London, at Bedford College for Women, Regent's Park, N.W.1. 5.15 p.m. Mr. W. Perceval Yetts, "Chinese Architecture."
At King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Meyendorff, "Public Finance in Eastern Europe." (Lecture I.)
At 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Kozyzanowski, "Renaissance Poland." (Lecture I.)
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture II.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture II.)
At University College, Gower Street, W.C.1. 5 p.m. Dr. H. R. Ing, "The Chemistry of Some Natural Drugs." (Lecture II.)
At University College, Gower Street, W.C.1. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture I.)
At University College, Gower Street, W.C.1. 5.30 p.m. Prof. A. F. Pollard, "Cardinal Wolseley." (Lecture III.)
Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. W. G. Constable, "Dutch Landscape."

FRIDAY, JANUARY 25..Electrical Engineers, Institution of, at the Gaiety Theatre, Dublin. 4 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)
Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. M. J. McCarthy, "Notes on Winches, Derricks and other Lifting Appliances used in Modern Building Construction."
Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. J. E. Lea, "Measurement of Coal Supplies in Small or Large Quantities."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) Prof. C. Vernon Boys, "A Fused Quartz Pendulum Rod for Clocks." (2) Mr. G. W. Sutton, "A Method for the Determination of the Equivalent Resistance of Air-Condensers at High Frequencies." (3) Mr. L. Hartshorn, "The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves."
Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. A. C. Seward, "The Vegetation of Greenland."
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture X—Ancient Folded Mountains" (*continued*).
Transport, Institute of, at the Adelphi Hotel, Liverpool. 6.30 p.m. Mr. C. C. Taylor, "The Reasons of Development of Road Transport in Recent Years."
University of London, at King's College, Strand, W.C. 5.30 p.m. The Rev. Principal J. Oman, D.D., "The Study of Religion: Lecture III—Problems."
At the London School of Economics, Houghton Street W.C. 2.30 p.m. Dr. W. Rose, "German Life and Literature from 1770."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture III.)
At University College, Gower Street, W.C.1. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture II.)

SATURDAY, JANUARY 26..L.C.C. The Horniman Museum Forest Hill, S.E. 3.30 p.m. Mr. H. Harcourt, "The Lure of India."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Monsieur E. Cammaerts, "Flemish and Belgian Art—The Landscape." (Lecture II.)

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FRIDAY, JANUARY 25th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 28th, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture II.)

WEDNESDAY, JANUARY 30th, at 8 p.m. (Ordinary Meeting.) GEORGE FLETCHER, M.A., F.G.S., M.R.I.A., late Member of the Water Power Resources (Ireland) Committee, "The Shannon Scheme and its Economic Consequences." SIR DUGALD CLERK, K.B.E., D.Sc., F.R.S., Past Chairman of the Council, will preside.

SWINEY PRIZE.

A meeting of the adjudicators of the Swiney Prize, appointed under the will of the late Dr. George Swiney, was held on Friday, January 11th, at the Royal College of Physicians. Sir John Rose Bradford, K.C.M.G., C.B., C.B.E., M.D., D.Sc., F.R.C.P., F.R.S., President of the Royal College of Physicians, was in the Chair. The Chairman reported that the Committee appointed by the Royal College of Physicians had examined the works submitted for the prize and were unanimously of opinion that the prize should be awarded to Sydney Smith, M.D., Regius Professor of Forensic Medicine, University of Edinburgh, for his work "Forensic Medicine."

On the motion of the Chairman, seconded by Mr. A. A. Campbell Swinton, F.R.S., it was thereupon unanimously resolved: "That the Swiney Prize be adjudged to Sydney Smith, M.D., Regius Professor of Forensic Medicine, University of Edinburgh, for his work 'Forensic Medicine.'"

COUNCIL.

A meeting of the Council was held on Monday, January 14th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Arthur Clarke, K.B.E.; Sir William Henry Davison, K.B.E., D.L., M.P.; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Alexander Gibb, G.B.E., C.B.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Mr. John S. Highfield, M.Inst.C.E., M.I.E.E.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir Richard Redmayne, K.C.B.; Mr. James Swinburne, F.R.S.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas, and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

A resolution of sympathy was passed on the death of Sir Henry Trueman Wood, M.A., formerly Secretary of the Society and afterwards Chairman of the Council.

The following candidates were duly elected Fellows of the Society:—

Aggiman, Jacques N., B.Sc., Angora, Turkey.
Bailey, Cornelius Oliver, M.D., Dallas, Texas, U.SA.
Barrow, G. C. R., London.
Blyth, George Edward Kevin, Ph.D., B.Sc., F.C.S., London.
Bousfield, Arthur, B.A., M.D., London.
Britain, Frank, London.
Budd, Herbert Ashwin, A.R.C.A., R.O.I., London.
Cadbury, Miss Dorothy Adlington, Bournville, Birmingham.
Child, Stephen Ambrose, M.A., B.C.L., London.
Christopher, James, Wetbank, Transvaal, S. Africa.
Cross, A. J., Bombay, India.
Davies, Rev. W. Tudor, West Wickham, Kent.
Fairfield, Commander Percy, R.N.R. (retd.), London.
Fairhurst, Lieut.-Colonel James Ashton, T.D., M.A., J.P., Newbury, Berks.
Ferrier, Henry T., Thornton Heath, Surrey.
Foxton, William, London.
Giles, Godfrey, London.
Girgis, Girgis Ibrahim, Port Tewfick, Egypt.
Haralampides, Michael Kleanthous, Paphos, Cyprus.
Hawken, Captain Cyril Charles Hamsworth, Bickley, Kent.
Kora, Popatlal Dahyabhai, Dharampur, India.
Lambert, Walter, Montreal, Canada.
Lyndon, Lamar, New York City, U.S.A.
McElhanney, T. A., Ottawa, Canada
Millett, Captain J. L. Vivian, London.
Naudain, Willis A., Wilmington, Delaware, U.S.A.
Nelson, Fred N., London.
Sinclair, Francis Richard, Belfast.
Wiles, The Right Hon. Thomas, P.C., London.

Sir Frank Warner, K.B.E., was appointed to represent the Society at the Centenary celebrations of L'Ecole Centrale des Arts et Manufactures, which are being held at Paris in May.

Preliminary consideration was given to the award of the Albert Medal for 1929.

The Report of the Joint Committee of Royal Society of Arts and the Royal College of Physicians recommending the award of the Swiney Prize to Sydney Smith, M.D., Regius Professor of Forensic Medicine at the University of Edinburgh, was approved.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

SEVENTH ORDINARY MEETING.

Wednesday, January 16th, 1929. Dr. Margaret Fishenden, D.Sc., F.Inst.P., of the Fuel Research Division, Department of Scientific and Industrial Research, in the Chair.

A Paper entitled "The Domestic Smoke Problem—a Practical Solution," was read by Professor Charles R. Darling, A.R.C.Sc.I., F.I.C., F.Inst.P. The paper and discussion will be published in the *Journal* on February 15th.

CANTOR LECTURES.

Monday, January 21st, 1929. Dr. R. Lessing, Ph.D., F.C.S., in the Chair. Dr. C. H. Lander, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the first of his course of three lectures on "The Treatment of Coal."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By Franklin Kidd, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

LECTURE I. Refrigeration in Nature.

(Delivered 12th November, 1928).

The Subject.

In Refrigeration there are perhaps three main divisions of interest. First, there is the engineering aspect; the mechanical production of low temperatures

in theory and practice; the properties and uses of insulating materials; the design and construction of refrigerating plants for various purposes. Secondly, there are the manifold uses to which the mechanical production of cold for the control of temperature and humidity are put in the manufacture of commodities, when at some stage or other of the process accurate control of temperature or humidity is of importance.

Lastly, there is that aspect of the subject in which we are concerned with the reaction of perishable food products, of plant and animal origin, to low temperature and to such other environmental controls as can be applied before, during, or after storage. It is with this aspect of the subject that we shall mainly be concerned in these lectures.

So much for our topic in general, but before going further, may I draw your attention to an antithesis which exists between science and industry, between knowledge and practice. It is an antithesis of motive in the human mind. When the interest is in industry, success in industry is the measure of achievement, and there can be but one criterion applied to knowledge:— Is it of any use? When interest is in knowledge, the goal is an abstract one. Satisfaction is not related to success in practical affairs. It lies solely in achieving a wider and more unified understanding of the nature of things.

FROM THE POINT OF VIEW OF INDUSTRY.

There are thus in our subject two entirely different approaches, which, however, subtly interlock.

There is the practical man's approach. Here we start with the elementary knowledge acquired by human experience that food products will keep better in cool weather than in warm, and we apply mechanical refrigeration which will give us a cool environment. We make the environment as cold as we can, with the broad distinction, based on common knowledge, that you cannot usually freeze a living plant without killing it and destroying its obvious properties; while dead carcasses can be frozen without altering in any striking manner the condition of the product.

When, however, these broad conclusions from general experience are applied, minor difficulties are met with and modifications in practice are developed as the result of more intensive experience. For example, complications arise from massing products together in the most confined space possible. Questions arise as to what is precisely the most efficient or optimum temperature at which to store various products. Freezing is found to have different effects on the muscle tissue of different animals.

Nevertheless refrigeration as a method for food preservation has been one of the industrial successes of the age. The number of products commercially handled under refrigeration is constantly increasing, and practically all the possible means by which cold can be applied have been tried, e.g., by forced air circulation, by simple exposure to cold pipes and by immersion in cold liquids.

From the industrial point of view, therefore, there is to-day concreted, as it were, round the simple fact that products are either chilled or frozen, a mass of technique varying in detail according to circumstances. The technique in any case is generally not an ideal one, but the best working compromise at present known, considering the vast number of variables usually attaching to any particular case.

The first possible method of approach would therefore yield a descriptive text-book in which particular products, producing centres and trade routes would be dealt with in turn; describing first what had emerged from empirical trials as to ideal treatment, and secondly the actual technique employed commercially in the stores, railways and markets.

From the Point of View of Science.

The other method of approach is that of the scientist. The biologist is concerned with the properties and behaviour of living organism. He attempts to describe in terms of physics and chemistry the sequence of growth, maturity, senescence and post-mortem decay. His object is to establish the laws by which behaviour is regulated in relation to environment and heredity.

From the biological point of view we can say at once that the fate of a food product must depend in the main on three variables—its racial character, its pre-storage nutrition and the temperature during storage. There are of course other storage factors such as humidity, the composition of the atmosphere, mechanical accidents of treatment, handling, etc., but these three are the most fundamental and important. You will observe they are all factors under human control.

You will observe also that, at the outset of any scientific study of refrigeration from the biological point of view, the field is extended to the pre-storage conditions, which determine the inherent nature of the product when it first comes into contact with refrigeration—its " inherent vice " or virtue.

Refrigeration in Nature.

An interesting introduction to the study of low temperature effects upon plants and plant produce is to be found in the great field laboratory of nature.

Let us consider the striking phenomenon of winter hardiness in plants. The broad features of the phenomenon are simple. Plant life as a whole possesses no heat regulatory mechanism or means of locomotion and is at the mercy of the temperature conditions of its environment. We find certain plants existing at temperatures many degrees below the freezing point of water. The leaves of evergreens during the severe conditions of a northern winter in Canada or Norway survive many degrees of frost. On the other hand there are many plants which cannot withstand freezing temperatures at all. Such forms are especially common among species adapted to growth in hot countries. We may, therefore, set ourselves the problem of ascertaining what special

properties are associated with the power of resistant forms to survive and preserve their living protoplasm intact when ice is formed in the tissue, or alternatively, what it is associated with ice formation which so easily kills non-resistant forms.

Allied to this phenomenon of the capacity or lack of capacity to tolerate freezing temperatures is the interesting fact that many plants cannot tolerate for long low temperatures, even when they are above the freezing point.

The Economic Significance of Winter Hardiness.

Owing to its greater economic significance the subject of winter hardiness or frost tolerance has received up to the present the most attention.

To producers the winter hardiness or cold tolerance of their trees and crops is often a matter of critical importance. Let me take two examples, cereal crops and fruit trees. In Canada and the United States they speak of test winters. Such were those ending the years 1872, 1884, 1898, 1917 in the North west, and in addition to the above also 1876, 1895 and 1903 in the East. During these test winters damage to fruit trees was often widespread and disastrous. After the severe 1906 winter a survey of 950 orchards in Maine showed 24,000 trees killed outright out of a total of 443,000, that is, about 6 per cent. As many more again were injured.[1]

The growers of the two staple crops, lucerne or alfalfa and wheat, the one of fundamental importance to the livestock industry and the other for the supply of bread, are faced in the northern parts of the U.S.A. and Canada with the same problem and hazard as the fruit growers—the problem of obtaining winter hardiness in their crops and the hazard of loss by winter killing. Winter killing is practically the only factor which limits the growing of winter wheat in the northern regions. It is not surprising, therefore, that a considerable amount of attention has been paid, especially in U.S.A. and Canada, both to the theoretical and practical aspects of this subject of winter hardiness.

Frost Tolerance Artificially Induced.

As soon as we begin to examine carefully in particular cases the reaction of various plants to the natural refrigeration of nature a number of generalisations come to light. We find in the first place that many plants which are immediately killed after even the mildest exposure to frost when such exposure overtakes them suddenly, as when removed from a warm greenhouse, can nevertheless withstand quite severe freezing conditions if they are "educated" to them by stages through intermediate temperatures. This is the process which growers term hardening. Withholding water from the roots for a period produces similar results.

A single experiment out of many carried out by Harvey in 1918 may be quoted, especially with reference to the effect of low temperature in inducing

[1]Morse, W. J. *Me. Agric. Stat. Bul.*, 164, 1909.

cold tolerance.[2] It is sufficiently striking. Harvey took two lots of young cabbage plants, grown in a warm bed. One lot he placed at a low temperature, 3°C., or about 38°F. The other he kept at 18°C. or about 70°F. Then at intervals he took specimens from each of these lots and exposed them to extremely severe freezing conditions for half-an-hour. The result was clear cut. The plants removed directly from the warmth to freezing conditions were without exception killed. Of the plants which had been allowed to harden during 5 days at 38°F., all survived, though exposed to the same degree of frost for the same length of time, and although in this exposure they had been frozen stiff.

AGE AND FROST TOLERANCE.

Again on the whole it may be said that the younger the tissue, the more able it is to survive exposure to low temperatures and the formation of ice. Perhaps I may remind you here that plants as distinct from animals are perennially young. They possess growing points, masses of undifferentiated cells rich in protoplasm, which, by continued multiplication and subsequent differentiation, build up what is in essence an infinite series of repeated parts, each part partially and sometimes wholly, after a certain stage, independent of the series as a whole. In any plant, therefore, there may thus be at the same time tissues and cells at the two extremes of the life cycle ; some essentially as youthful as the products of the first division of a fertilised egg cell ; others on the point of death, wonderfully modified in appearance and form after a life of stressful experience.

Here then is an observation made categorically by Martin of the Bureau of Plant Industry of the U.S.A. after a very thorough study of the comparative hardiness of different wheats.[3] " The crown is the most hardy portion of the wheat plant above the surface. Young leaves are more hardy than old leaves and the bases of leaves (i.e. the youngest parts) are more hardy than the tips." Or again there is the conclusion reached by Winkler after a long series of experiments with plants in freezing mixtures both during summer and winter.[4] " The youngest leaves of evergreens are more cold resistant than the older." The natural life of the leaves of the evergreens, as you know extends to three or four years, so that these leaves afford convenient material for studying the problem of age and cold resistance in plants. The great cold resistance of the embryonic cambium tissue as compared with the wood or bark in dormant trees has been frequently noted and accounts for the recovery of trees after severe injury.[5]

The influence of frost tolerance may be obscured owing to differences in the state of dormancy in tissues of different age.

[2]Harvey, R. B. *Jour. Agric. Research*, 15, 1918.
[3]Martin, J. H. *Jour. Agric. Research*, 35, 1927.
[4]Winkler, A. *Jahrb. für Wissenschaft. Bot.*, 52: 467-506. 1913.
[5]Chandler, W. H. *Mo. Agric. Exper. Stat. Research Bul.*, 8, 1913. *Proc. Am. Soc. Hort. Sci.*, 1918.

DORMANCY AND FROST TOLERANCE.

Another generalisation of interest and significance is that dormant, as opposed to active tissues, are far more hardy. The rest period in plants, in which young as well as old tissues equally participate, is a very interesting phenomenon. It has been studied most in the case of woody plants whose natural habitat is in the temperate zones, and in the case of seeds. Recently in the Missouri Agricultural Experimental Station some 300 species of woody plants were submitted to very thorough investigation with regard to this point. The phenomenon is briefly this. As Autumn advances there ensues a slowing down of cell activity. The causes which induce this resting stage are not very well understood, but, in general, experiment and observation point to two main conditions which are effective, (1) drying, that is to say the withholding or removal of water and (2) exposure to temperatures which are low but above the freezing point. One may note that the two conditions which are broadly associated with the induction of the dormant or resting state are identical with the treatments, well known to growers, which are used to harden plants when they are transferred from hot-house conditions to the open and to the liability of exposure to frost.

There is, however, much evidence of an inherent periodicity in plants, in alternation between rest and activity. Equatorial regions with uniform temperatures present the phenomenon of plants, some in the resting stage while others are in growth. Sometimes, even on the same tree, one branch may be resting, while another is in active growth.

When once the dormant condition is established, it is not broken merely by establishing artificial spring conditions, for example, by bringing cut branches or whole plants into the green-house.

In the Missouri investigation 300 species of woody plants were found to have a definite rest period, and it was, moreover, clearly shown that the length, onset and intensity of the rest period were (as judged by the intensity of measures needed to break it) definite racial characters distinguishing varieties and species.

Numerous observations appear to establish definitely the main thesis that tissues are better able to withstand freezing temperatures when in a dormant state, and the following figures illustrate the progress and magnitude of the phenomenon.

Some experiments of Chandler and of Strausbaugh are interesting. Chandler estimated first the relative cold tolerance of a number of peach varieties by studying the percentage of buds killed in the severe winter of 1905-6. In the following year he took shoots in the winter and estimated the number of buds which could be forced into development at different dates. There appears from his results a rough parallelism between the stability of the resting state in different varieties, and the degree of resistance to severe winter conditions.[6]

[6]Chandler, W. H. *Mo. Agric. Exper. Stat. Bul.*, 74, 1907.

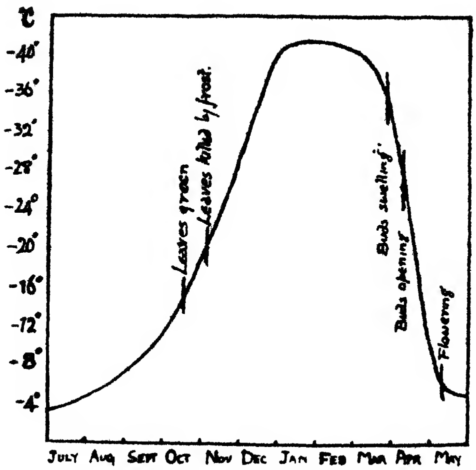

FIG. 1.—Seasonal variation in the killing point of shoots of an apple tree of the Jonathan variety. In the experiments on which this curve is based the shoots were cooled in a refrigerator at the rate of 5° C. an hour and exposed 3 hours to the test temperatures. The temperature was then raised at the rate of 5° C. an hour and shoots after thawing examined for injury. (Hildreth.)

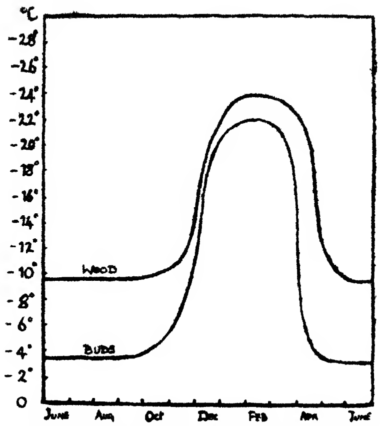

FIG. 2.—Winkler's Summary of his experiments carried out with the shoots of a large number of different species of deciduous trees. The curves represent the seasonal variation in the depth of freezing required to kill in a typical case, *i.e.*, *Populus nigra*. Cooling time 1 to 3 hours: duration of exposure 9 to 11 hours.

Variety.	Percentage of buds winter-killed.	Percentage of buds which could be forced into growth on December 22nd.
1	39·7	40·7%
2	44·3	6.7
3	51.2	13.0
4	50.6	8.7
5	79·1	86.7
6	78.9	65·7

Strausbaugh on the other hand took plum twigs from varieties known to be hardy and from others known to be tender and found that while he could force the latter into growth and flowering during the winter, the former did not react.[7]

Nutrition and Frost Tolerance.

Let us turn next to the question of nutrition. Can any generalisation be made as to the effect of particular factors in nutrition upon capacity to maintain the structure of the living protoplasm intact in the face of extreme cold and ice

[7]Strausbaugh, P. D. *Bot. Gaz.*, 71, 1921.

formation? Can we even say that nutrition has any effect at all upon this property. Unfortunately I cannot point to you any actual experiments bearing upon this issue, but there are certain observations which are interesting and suggestive.

For example it has been noted by many and put on definite record by Macoun, that fruit trees are much more susceptible to frost damage after a heavy crop, than when they have borne no fruit the previous autumn. I give you one of his observations. " Of fourteen trees, the eight which bore a medium to good crop in 1917 were killed or badly injured while the six which had either a light crop or no crop at all, came through in good condition."[8]

Pruning and manurial practices very definitely affect winter hardiness. But here the effects, as shown in Nature's laboratory, are difficult to unravel because of the effect of these treatments upon the onset of the resting state independently of any effect they may have on the capacity to withstand specific temperatures at specific stages in rest or activity. Looked at from the horticultural point of view, which is the one from which these phenomena have been most studied, fruit trees according to the district they are growing in are either more in danger of frost in autumn before they have entered their rest stage, or more in danger in spring from the fact that the natural term of rest ends before frosts severe enough to injure are over. Variations in natural conditions or artificial treatments which come under nutritional factors and which favour winter survival are generally believed to do so by either postponing or accelerating the onset of the rest period.

RACE AND FROST TOLERANCE.

The last general feature to be described with regard to winter hardiness is the influence of race. You understand of course the contrast between fruit trees of any given variety and a species such, for example, as the oak. All the trees of any given variety of fruit tree are reproduced vegetatively by grafts from one original, and are, therefore, genetically, but a single individual arising from a single fertilised ovum. Within a species, however, every individual that arises from a seed, that is, from a fertilised ovum, is probably racially distinct in some degree from every other individual.

The animal breeder or the breeder of plants propagated by seed is always faced with the difficult problem of fixing the strain. The fruit grower has generally an easier solution. He simply cuts pieces from his selected parent plant and gets them to grow either by sending out roots of their own or grafting them on to other already rooted plants. Though it is common with vegetables there are few fruits which are grown from seed.

An interesting example which illustrates the range of genetic variation within a single species in relation to the property of winter hardiness may be quoted. Wentling, of the Department of Forestry of the University of Min-

[8]Macoun, W. T. *Proc. Am. Soc. Hort. Sci.*, 1918.

nesota, collected native seeds of *Quercus rubra*, a species of oak, from the southern, central and northern regions of the natural distribution of this species in North America, and planted them all together for comparison in the northern region. They all made good growth in the spring and summer after planting. But the effect of the ensuing winter was clean cut. All the seedlings originating from Southern seed were killed, roots and tops; those of central origin were killed to the snow line, while those from the north were uninjured.[9]

The result of this striking experiment may perhaps be due partly to the existence of racial variants as regards the time of onset and duration of the rest period, as well as upon racial variation as regards capacity for resisting cold.

That racial variants within a species exist with regard to the specific capacity of withstanding cold seems well established from much human experience and vast and costly experiment with apple varieties. We can regard the many varieties of apples as racial variants within the species, isolated or fixed by artificial propagation (eliminating the sex stage of ovum and fertilisation). Among these variants there exists a wide and marked difference in the capacity to resist injury from frost. There is a northern limit to the cultivation of every variety. Certain Crab apples can probably penetrate further to the north than any cultivated variety. The variation in frost tolerance between different cultivated varieties has recently been clearly demonstrated by artificial freezing tests in refrigerators.

Breeding and Selection for Storage Properties.

The fact that the capacity to withstand freezing temperatures is a genetic factor, may be of particular importance in relation to cold storage, because it suggests at once the possibility of breeding and selection as a method of improving storage quality in many types of animal and plant produce.

We shall see later that one of the most important storage qualities in fresh fruits is their capacity to tolerate for long periods low temperatures *above the freezing point*, and that this quality also is inherited. More will be said on this matter in my next lecture. It will be sufficient for the moment to state that it is becoming increasingly clear that for living products there exist critical lower limits of temperature, below which they cannot be stored for any considerable period without depreciating in flavour and condition, or even actually breaking down and becoming inedible.

Since so many of our commercial fruits are reproduced and multiplied merely by subdivision of the bodies of individuals and not by the production of male and female cells and the growth of new individuals from fertilised ova, a word must be said about the origin of new race variants in such cases. Many careful observations have definitely established the fact that permanent bud-variants, that is somatic racial mutants, do arise occasionally and that in some species they arise and are arising much more frequently than in others.

[9] Dorsey, M. J., and Bushnell, J. W. *Proc. Am. Soc. Hort. Sci.*, 1920.

If such mutation is in regard to characters not revealed under their existing conditions, for example, in regard to cold storage qualities, they must pass unnoticed and gradually accumulate in the population from which the grower is continually renewing and multiplying his plants for cropping.

With the world wide industrialisation of production and distribution, storage of produce of all kinds has become a pivotal operation. But while the properties of plants and animals in regard to yield and certain aspects of quality, have long been studied, those particular qualities which render them good or bad keepers in storage have only come under notice as of first rate importance within recent years.

You will follow then the broad trend of my suggestion. Just as other desirable properties have been obtained and improved by breeding and selection, so may those properties associated with good keeping in cold storage.

But to-day the modern world, under the guidance of the scientific method, is not prepared to leave this development to the vast cumbersome process of natural selection by trial and error in the industrial arena. Rather will low temperature research and storage research stations in all the leading countries of the world be employed in order to submit to definite trial and standardisation the storage qualities of new racial variants produced by the breeder.

The Physiology of Frost Injury.

We turn now to consider why it is that freezing is so often followed by injury or death. We may first ask how and where does the ice form in the tissues.

In general, the usual position for ice formation is between the cells. Less frequently is it found within the cell, in the vacuole enclosed by the living protoplasm. Here is a description of his observations by Wiegand, who investigated the ice formation taking place in the buds and twigs of fruit trees.[10] " The ice . . . usually formed a single continuous layer throughout the mesophyll of the scale or leaf, to accommodate which the cells were often separated to a considerable distance. This ice sheet was composed of either one or two layers of the prismatic crystals, depending on the water content of the adjacent surfaces, and was often as thick as the whole normal scale. The cells surrounding the ice, having lost their water content, were in a more or less complete state of collapse, depending upon the resistance of the walls, and often occupied a space smaller than the ice itself. These cells were uninjured, however, and would resume their normal condition on thawing . . . In young anthers the ice often filled the entire anther cavity and in it the pollen grains were imbedded in a completely collapsed state." In general, the species in which ice formed most readily had larger cells, a higher water content and a greater proportion of water to cell wall and protoplasm.

[10] Wiegand, K. M. *Bot. Gaz.*, 41, 1906.

" In the twigs," Wiegand states, " ice is also present in very cold weather, where it may be found in three different localities. The largest quantity occurs in the cortex, where the ice crystallizes in prisms arranged in single or double series. The ice is more frequently in the form of a continuous ring, or really a cylinder, extending entirely around the twig, prising apart the cells of the cortex in which it lies. The outer cylinder of cortex in such twigs is completely separated from the inner layers when frozen. In a few species instead of the continuous layer, lens-shaped ice masses are interpolated irregularly throughout the cortex. The cortical cells after the withdrawal of water are as completely collapsed as were those in the bud scales, but they also usually regain their normal condition on thawing. In the wood ice rarely forms in large quantities. It is usually confined to small masses in the vessels themselves, or, according to some authors, sometimes extends in radial plates in the pith rays. In sectioning twigs, I, myself, have never seen ice in the wood elsewhere than in the vessels or wood cells. In the pith the ice, so far as I have been able to observe, always occurs within the cells and therefore in very small masses."

Müller-Thurgau, a pioneer observer in the field of the effects of low temperatures upon plants, showed as long ago as 1880 that rapid freezing tends to produce small and irregular ice crystals while slow freezing larger and more regular ice masses. He associated the formation of ice inside the cells with rapid freezing.[11]

Frost Injury and Thawing.

The earliest investigators held the view that it is only on the thawing of the ice that the fatal disorganisations of frost injury set in. This view, in its absolute form, was eventually disproved by the observation of post mortem effects in the still frozen tissues. There is a red marine alga Nitophyllum which on death and consequent disorganisation exhibits a brilliant orange red fluorescence. When cooled to —5°C., this fluorescence soon becomes obvious. The unnatural and often disagreeable odours and flavours which develop in some fruits while frozen are probably post-mortem products. The browning of frozen apple tissue or of frozen plums, which slowly occurs when these fruits are kept frozen, are certainly post-mortem changes.

In recent investigations the question of the rate of thawing has been considered and there is evidence that rapid thawing may sometimes cause injury, that is to say, injury which would not occur, if the thawing were slow. Here are the results of some experiments carried out by Hildreth.[12]

" Wealthy " apple shoots frozen for three hours at —35°C.

[11]Müller-Thurgau, H. *Landw. Jahrb*, 9, 1880; 11, 1882; 15, 1886.

[12]Hildreth, A. C. *Minn. Agric. Exper. Stat. Tech. Bul.*, 38, 1926.

Rate of Cooling.		Rate of thawing.	Relative injury. %
5°C. per hour	Rapid.	By immersion in water at +15°C.	64.4
,,	Rapid.	By immersion in mercury at +30°C.	65.5
2.5°C. per hour.	Slow.		8.8

FROST INJURY AND DESICCATION.

The older view that thawing caused the injury was succeeded by the hypothesis that death and disorganisation were to be traced to the effects of the desiccation which resulted from the withdrawal of water in the formation of ice. It is well known of course that in the case of most plant tissues, desiccation results in the disorganisation of the living mechanism and consequent death.

In tissues which can withstand desiccation, such as seeds, slow changes go on in the dry material. These changes are irreversible and end in the destruction of the living organism. Different seeds have very different life-durations in the dried state, that is to say, the time they remain viable or able to germinate on addition of water differs.

In the same way it has been found that the duration of exposure often has a pronounced effect on the degree of injury resulting from freezing. One may again quote Hildreth, taking his observations on terminal buds slowly cooled and held at —30°C. for three hours as compared with twelve hours.[13]

Apple variety.	*3 hours.*	*12 hours.*
Winesap	dead	dead
Wealthy	no injury	dead
Duchess (Oldenburg)	no injury	dead
Hibernal	no injury	nearly dead.

Mez, in 1905, as the results of his experimental work in cooling plant tissues to —14.5°C. reached the conclusion that death by cold desiccation was only exceptional.[14] Mez was one of the earliest to pay close attention to cooling curves. He found that in cooling, the tissues he observed behaved exactly like solutions of their constituent substances. Their temperature first fell rapidly till ice began to form ; then slowly during the slow concentration of the solutions and consequent lowering of the freezing point, until it became approximately constant, at which stage ice and solute crystallised out together. Only finally, when the whole mass was solid did the temperature fall again. Mez found —6°C. to be the apparent eutectic point and argued that at this temperature "cold desiccation" must be complete, and that no further injury from this cause was possible by further cooling. The conclusion he reached from his experiments in cooling to —14.5°C. was that low temperature had a specific effect independent of desiccation and that there was a different fatal minimum temperature for different cells and for different classes of tissue.

[13]Hildreth. *Loc. Cit.*
[14]Mez. *Flora*, 94, 1905.

Frost Injury and the Effect of Concentrated Salt Solutions in the Tissues.

Gorke's experiments must next be considered.[15] He took up the point as to the effects which the solutions of the salts in the sap, concentrated after the separation of ice, may have upon the colloidal condition of the protoplasm. Natural proteins are known to be precipitated by concentrated neutral salts. The precipitates become permanent after a time. They can be re-dissolved by dilution only if this is not too long delayed. Gorke submitted the expressed sap of tender and hardy plants to low temperatures and obtained permanent precipitates of protein, the temperatures required ranging from —3°C. for a tender plant like Bryonia, —15 for winter rye, to —40°C. for Pine needles.

Another possible effect of salt solutions, when concentrated under the influence of ice formation, is their solvent action upon certain constituents of the colloidal complex of the living protoplasm. Dr. Moran's recent work at the Low Temperature Research Station on the irreversible changes which are associated with the freezing of the yolks of eggs is extremely interesting in this connection.[16] A frozen egg yolk on thawing is found to have lost its original fluid condition, and to have become tacky and pasty in consistence much as if it has been " soft " boiled. Dr. Moran's researches indicate that the lecitho-vitellin complex in the colloidal aggregate is dissolved out in the concentrated solution of salts formed after the separation of ice. Upon thawing and consequent dilution precipitation takes place. Experiments with lecitho-vitellin, as an isolated substance, show that it is dissolved in a 10 per cent. solution of NaCl and that it is thrown out of solution and precipitated by adding water. The freezing point of a 10 per cent. solution of NaCl is about —6°C., and this is the critical temperature below which the yolk must not be carried in the frozen state if the irreversible change described above is to be avoided.

Frost Injury and the Rate of Cooling.

Two sets of experiments, one by Kühne and the other by Molisch, illustrate the striking degree to which the rate of cooling may influence the phenomenon of ice formation and frost injury in plants.[17] In the fine hairs that grow on the stamens of some plants, (*Tradescantia Virginica* was used by Kühne and *Tradescantia crassula* by Molisch), the living protoplasm maintains an active streaming movement. Kuhnë froze these hairs rapidly in a platinum crucible which he placed in a freezing mixture at —14°C. They are so small that their freezing must have been practically instantaneous. Ice formed throughout the

[15] Gorke, H. *Landw. Vers. Stat.*, 65, 1907.

[16] Moran, T. *Proc. Roy. Soc. B.*, 98, 1925; *Proc. 4th Cong. of Refrig.*, 1, 1924.

[17] Molisch, H. *Untersuchungen über das Erfrieren der Pflanzen*, Tena, 1897. Kühne, W. *Untersuchungen über das Protoplasma*, Leipzig, 1864.

cell and on thawing active streaming movements in the protoplasms were re-established within ten minutes. In Molisch's experiments freezing was slow; 30 minutes elapsed before ice began to form, after the material was placed on the stage of the microscope under freezing conditions. After thawing, the cells were quite dead.

In contrast to the above, several investigators using more bulky material have found less injury after slow freezing. Winkler, for instance, found that he killed beech (*Fagus sylvatica*) and oak (*Quercus pedunculata*) buds by taking shoots immediately to —22°C. or lower ; but when he allowed them to remain 3 days at —16°C., 3 days at —18°C., 3 days at —20°C., 2 days at —22°C. and 3 days at —25°C. they finally withstood without injury 12 hours at so low a temperature as —30°C.[18] Similarly, dormant apple twigs have been found much less injured by cooling at the rate of 5°C. an hour to —35°C. followed by 3 hours, exposure to this low temperature, than similar shoots taken suddenly to —35°C.[19]

PHYSIOLOGY OF FROST TOLERANCE.

The last topic to be dealt with here is that of the changes which underlie the increase of cold tolerance during the hardening process. This topic must be introduced by a very brief consideration of temperature co-efficients. Every chemical or physical change, other things being constant, goes on at a definite rate which depends upon the temperature of the system in which the change is occurring. The higher the temperature the faster the rate. But all individual chemical or physical changes are not affected by temperature to the same degree. In a system or machine consisting of a series of linked changes, one change depending on the product of another, such as we believe the living cell to be, a change of temperature will, therefore, not only effect the net speed of the whole, but also the balance of the parts. Change in the balance of the parts will reveal itself in a change in composition. There will be more of some products and less of others present at any time.

The effect of lower temperature for reducing the net speed of the complex of changes which produce ripening, growth, senescence and post-mortem decay is, of course, the effect of temperature upon which cold storage practice primarily depends. The change of balance and in composition produced by low temperatures is, however, a subsidiary effect which is of great importance. It is of special importance in regard to the influence of cool storage upon the quality of the produce, that is to say, upon the relative content of sugar acids, proteins and fats and aromatic flavouring substances. It is of special importance, also, in regard to the injurious effects which may be produced by long exposure to low temperatures (above the freezing point) and with regard to the ability to resist freezing and survive ice formation. How important to biological

[18] Winkler. *Loc. Cit.*
[19] Hildreth. *Loc Cit.*

organisms is this question of the balance of their physico-chemical systems and the effect of temperature upon this balance, may be illustrated by the high degree of specialisation in temperature control exhibited by the mammals. The human body, for example, is one of the most marvellously adapted thermostats in existence.

Increase in Sugar Content at Low Temperatures.

With this slight theoretical introduction let us return to the laboratory of Nature and consider Lidforss's observations on the winter-green flora of South Sweden.[20] Lidforss found that in the leaves of cold tolerant plants—often apparently delicate herbaceous annuals such as Veronica, Senecio, Viola and Fumaria—there was one outstanding general characteristic in winter. All the starch which is present as a large component in the tissue in summer was transformed to sugar. He set up the thesis, therefore, that cold tolerance was associated with a change in balance leading to the accumulation of sugar at the expense of starch and set out to check his thesis by further observation and experimentation. He showed that by keeping cut leaves with their stalks in sugar solutions for a few days, and so getting them to take up sugar, they were rendered cold resistant. Sugar-leaves exposed to —7°C. remained uninjured, while controls kept alongside them in water, were killed. He found also that in submerged water plants, which wintered above the freezing point, starch was not entirely changed to sugar and that associated with this, such plants were killed by freezing at —2°C. Water plants, however, which are in part exposed to the air, such as *Ranunculus lingua*, lose their starch and withstand temperatures of —7°C. Lastly, the starch sugar change is reversible, so that with warmer weather, on the return of spring, starch reappears, and in this is seen an explanation of the fact that a *sudden* though mild cold snap, after a warm spell in spring is often far more damaging than the deepest cold of mid-winter.

It may be regarded, therefore, as established that sugar exercises a protective action against frost injury. As to how this protective effect came about, whether by preventing the precipitation and dissolving action of concentrated salt solutions upon elements in the colloidal matrix of the protoplasm or by increasing the water-holding power of the system as a whole against ice formation is not clear. Moran found that egg yolk was protected by the addition of sugar from the irreversible effects of exposure to freezing between —7°C. and —11°C.

Certain plants which form and contain great quantities of sugar are notably susceptible to cold, such as the sugar cane and the sugar beet. It is clear, therefore, that the protective action of sugar which accumulates during hardening at low temperature and also incidentally under the influence of water shortage is not the only factor responsible for frost tolerance.

[20] Lidforss. *Die Wintergrüne Flora*, Lund, 1907.

The change of balance resulting in the accumulation of sugar at the expense of starch at low temperatures, which was first thoroughly studied in potatoes by Müller Thurgau in 1882, is probably a typical case of a wider generalisation to the effect that down-grade products of hydrolysis accumulate at the expense of up-grade products of condensation—simpler down-grade products at the expense of more complex up-grade products. It has been found, for instance, by Harvey that during the process of hardening by exposure to low temperatures above the freezing point, there is an accumulation of the cleavage or hydrolysis products of protein.[21]

INCREASE IN WATER HOLDING CAPACITY OF CELL COLLOIDS.

In view of the various aspects of this interesting problem of frost resistance, which we have so far reviewed, it is rather surprising to find that very few attempts have been made actually to measure the amount of ice formed in tissue at various temperatures below the freezing point. I need not here go into the methods and difficulties of doing this with accuracy, but after reminding you that Plank found only 76 per cent. of the water in meat frozen at —7°C.[22] I will bring this lecture to a conclusion by briefly describing the investigations of Hooker, Rosa and Martin.

Rosa comparing 100 grams of hardened leaves with 100 grams of tender leaves found a greater absolute amount of water remaining unfrozen at different temperatures in the hardened leaves, in spite of the fact that the total amount of water in a hundred grams of hardened leaves is less to begin with. The following are some of his figures for grams of water unfrozen in 100 grams of leaf.[23]

	hardened	tender
—3°C.	60 grams	35 grams
—4°C.	43 ,,	22 ,,
—5°C.	35 ,,	16 ,,
—6°C.	30 ,,	14 ,,

The increased water-retaining capacity of the system after hardening, thus indicated by these and other similar results of measurements of the actual amounts of ice formed, are most probably to be attributed to increased inhibitional or capillary forces in the colloids. For instance in support of this view Hooker obtained some evidence by first killing and air drying hardened and unhardened tissues, and then exposing the material thus obtained to definite water vapour pressures over sulphuric acid. They found that, in equilibrium with any given water vapour pressure, the hardened material held more water than the unhardened.[24]

Chemical analyses carried out in connection with the work of these two authors appear to indicate that this increased water holding power is associated

[21]Harvey. *Loc. Cit.*
[22]Plank, R. *Z. ges. Kalte-Ind.*, 32, 1925.
[23]Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 1921.
[24]Hooker, H. D. *Proc. Am. Soc. Hort. Sci.*, 1920.

with the accumulation of water soluble polysaccharides of the pentosan class—the class which give cacti their great water holding power.[25]

This discovery of the association between frost tolerance and the water holding capacity of the cell colloids, has recently been applied in an ingenious way to distinguish between winter hardy and tender wheats—a very important thing to be able to do without waiting for test winters when new varieties are being bred. Martin simply submitted the tissues to a standard hydraulic pressure and measured the juice pressed out. He concluded that the most important character influencing hardness is the ability to build up a high inhibitional pressure of the cell colloids during hardening.[26]

SUMMARY OF FACTORS DETERMINING FROST INJURY IN PLANTS.

In these few examples we have touched briefly on a few of the outstanding factors which may enter into the question of injury, or the occurrence of irreversible changes when living tissues are frozen. There is the speed of cooling, affecting the manner in which ice is formed; the temperature reached and the water-holding power of the cell systems, affecting the amount of ice formed; the influence of increased salt concentration upon the colloidal state of the protoplasm; the time of exposure, affecting the extent of slow changes in the desiccated colloids. To these variants must undoubtedly be added the specific nature of the colloidal constituents, and of the salts of different tissues. Such then are the possibilities which are to be subjected to detailed quantitative investigation when any specific case of freezing injury or more broadly, of non-reversibility in freezing-thawing cycles are in question.

Our study of plants in the laboratory of Nature has led us to see that though low temperature and freezing may appear the obvious method of retarding changes in stored food products, closer consideration has indicated that there are many complications both in living and post-mortem systems. These complications form the interest and field of the biologist and I hope that to-night, as an introduction to my two following lectures, I have been able to give you some slight acquaintance with their nature.

[25]Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 1920.
[26]Martin, J. H. *Loc. Cit.*

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 28.. Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Mains Testing," opened by Mr. F. C. Raphael.

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."

At Bristol. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture).

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin." Lecture XI: "Other Tectonic Mountains."

University of London, at King's College, Strand, W.C. 5.30 p.m. Major-General Sir Frederick Maurice, "Allenby's Campaign in Palestine." (Lecture III).

At University College, Gower Street, W.C. 2 p.m. Prof. H. E. Butler, "The Rome of Virgil and Horace."

At University College, Gower Street, W.C. 5 p.m. Mr. G. P. Crowden, "Fatigue." (Lecture III).

At University College, Gower Street, W.C. 5.30 p.m. Prof. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture III).

At University College, Gower Street, W.C. 5.30 p.m. Mr. C. H. Collins Baker, "The Dutch School of Landscape Painting."

TUESDAY, JANUARY 29..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Prof. J. L. Myres, Presidential Address.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Messrs. J. H. Hyde and H. R. Lintern, "The Vibrations of Roads and Structures." (further discussion).

Electrical Association for Women, at 15, Savoy Street, Strand, W.C. 7 p.m. Mr. F. W. Purse, "How Electricity is generated at West Ham."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

At the North British Station Hotel, Edinburgh. 7 p.m. Mr. E. Seddon, "Recent Extensions to Portobello Power Station."

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. B. P. Dedding, "Errors in Testing Bulb Supply by Random Selection."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species."

University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. P. Dearmer, "Dutch Painting." (Lecture III).

At King's College, Strand, W.C. 5.30 p.m. Prof. R. W. Seton-Watson, "The Eastern Question." Lecture III: "The Rise of Nationality and the Revolutionary Wars."

At University College, Gower Street, W.C. 5.30 p.m. (Lecture I) of Course on "The Current Work of the Biometric and Eugenics Laboratories."

WEDNESDAY, JANUARY 30..British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. The Very Rev. W. R. Inge, D.D., "Plotinus."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. H. G. Cousins, "Design and Construction of Victoria House."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin." Lecture XII: "Subsequent or Relict Mountains."

United Service Institution, Whitehall, S.W. 3 p.m. Sir Norman Leslie, Bt., "The Mercantile Marine in a Future War."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "Contemporary Russian Literature, 1917-1928." Lecture III: "Solitary Poets: Khlebnikov, Pasternak, Isvetaveva."

At King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History." Lecture III: Mr. A. T. Bolton, "The English House (later periods)."

At the London School of Economics, Houghton Street, W.C. Mr. Ernest F. Bean, "Some Uses of the Sundstrand Machines."

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture III).

At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La lirica del Paradiso." (Lecture II).

At University College, Gower Street, W.C. 5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture III).

At University College, Gower Street, W.C. 5.30 p.m. Mr. W. E. Doubleday, "The History of the Public Library Movement, to the end of the 19th Century."

At University College, Gower Street, W.C. 5.30 p.m. Prof. Tancred Borenius, "Rembrandt and Italian Art."

At University College, Gower Street, W.C. 5.30 p.m. Mr. J. H. Helweg, "The Renaissance Period in Danish History and Literature." (Lecture III).

THURSDAY, JANUARY 31..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. W. S. Farren, "Monoplane or Biplane?"

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Linnean Society, Burlington House, W. 5 p.m.

Mechanical Engineers, Institution of, at the Engineers' Club, Manchester. 7.15 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Mr. H. V. Nanchester, "Indian Architecture."

At King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "Czechoslovakia." Lecture III: "The Great War and Czechoslovak Independence."

At King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Mevendorff, "Public Finance in Eastern Europe." (Lecture II).

(Kings College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." Lecture II: "Chroniclers and Historians."

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture IV).

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture II).

At University College, Gower Street, W.C. 5 p.m. Dr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture III).

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450-850." (Lecture I).

At University College, Gower Street, W.C. 5.30 p.m. Prof. A. F. Pollard, "Cardinal Wolsey." (Lecture IV).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Maurice W. Brockwell, "Rembrandt as a Painter."

FRIDAY, FEBRUARY 1..Chemical Industry, Society of, at Milton Hall, Deansgate, Manchester. 7.30 p.m. Dr. F. Challenger, "The Sulphur Compounds of Shale Oil and Petroleum."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. T. H. Cross, "Notes on Road Construction."

Mechanical Engineers, Institution of, Great George Street, S.W. 6 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture).

At the Chamber of Commerce, Birmingham. 7.30 p.m. Mr. E. H. Pease, "Recent Developments in Multiple Drilling and Tapping."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. V. G. Childe, "Philology and Archæology."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. J. L. Myres, "Geometrical Art."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. J. H. Rose, "Ibrahim Pasha in Morea and the Battle of Navarino."

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. C. E. R. Sherrington, "The Steam Railways and the Localising of Industry in the Nineteenth Century."

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture III).

SATURDAY, FEBRUARY 2..L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "The Ancient Egyptian Potter and his Clay."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Cammaerts, "Flemish and Belgian Art—Genre Painting."

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FRIDAY, FEBRUARY 1st, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 4th, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture III.)

WEDNESDAY, FEBRUARY 6th, at 8 p.m. (Ordinary Meeting.) SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture.) SIR GEORGE SUTTON, Bt., Chairman of the Council, will preside.

FRIDAY, FEBRUARY 8th, at 4.30 p.m. (Indian Section.) CAPTAIN SIR E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., "The History of the Indian Marine." VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, late Commander-in-Chief, East Indies Squadron, will preside. Tea and coffee will be served in the library from 4 p.m.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JANUARY 23rd, 1929. THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., in the Chair.

A paper entitled "Museums and Education" was read by SIR HENRY A. MIERS, D.Sc., LL.D., F.R.S. The paper and discussion will be published in the *Journal* on February 22nd.

CANTOR LECTURES.

MONDAY, JANUARY 28th, 1929. DR. R. LESSING, Ph.D., F.C.S., in the Chair. DR. C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the second of his course of three lectures on "The Treatment of Coal."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By Franklin Kidd, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

LECTURE II. Refrigeration and Fruit.

(Delivered November 19th, 1928).

Retrospect.

In considering the subject of Refrigeration as applied to the preservation of food stuffs, we set out by drawing a distinction between two possible methods of approach, and indicated that a certain fundamental antithesis in motive must exist between those whose life work was directed along one or other of these two lines—between those whose object is to develop and make a success of the industries of food production, transport and storage, and those whose interest lies in obtaining a deeper knowledge of the nature of things.

We next passed to consider the great diversity of food stuffs, plant and animal; living and post-mortem; eggs, fish, meats and poultry; fruits, green leaves, resting organs and growing points of plants. Considerable diversity also exists in the ways in which cold is applied in practice, and in the varying limitations imposed on ideal procedure when food stuffs are stored and handled under commercial conditions.

Following out the practical line of approach we had to contemplate, therefore, what would amount to a text-book taking particular products, producing centres and trade routes in turn.

We took then the other line of approach and I gave you a rapid survey of what can be learnt about the effects of low temperature upon biological material from a study of the behaviour of plants in nature.

We considered particularly the resistance or otherwise of plants to freezing temperatures—their capacity to survive severe frosts. Great differences exist between different species of plants in this respect, and certain plants which, if brought suddenly into the cold, are unable to tolerate the least touch of frost, can nevertheless be educated to a considerable degree of frost tolerance. We found that young tissues were often far more tolerant of freezing temperatures than old tissues, and that within any species there were racial variants as regards frost tolerance. We saw also that there was a rhythm of rest and activity in plants, and that in the resting stage cold-tolerance

was often increased to a most striking extent. Finally we found that the onset of rest and the "education" of plants to cold tolerance could be artificially brought about.

We examined next how and where ice was formed in plant tissues and we saw that the difference between cold resistant and non-resistant plants, or between hardened and non-hardened plants, or between the destruction of the delicate organisation of the living protoplasm and its survival, depended on a number of factors; for example, the effects of the concentrated salt solutions formed when pure water is withdrawn from the living system in the formation of ice, the accumulation of such substances as sugar in the tissues, and finally the variable water holding capacity of the colloidal or jelly-like constituents of the living cells.

In the course of this survey of the effect of freezing temperatures upon living plants, it must have been obvious to you, though I did not stress it, that we were on the same ground as in studying the effects of freezing upon post-mortem tissues such as meats—with this advantage, that in death we have a highly sensitive and easily observed indicator of irreversible disorganisation.

THE APPLE—ITS PROPERTIES AND BEHAVIOUR.

We are to turn now to one food product in particular, namely, the apple. The apple, the orange and the banana are three of the world's principal fruits of commerce to-day. I shall deal with the apple, because by devoting most of our time to this one fruit, I shall be able to illustrate to you more fully what is involved in a study of the nature and behaviour of a plant food-product, and secondly how such a study yields results of practical utility in regard to the storage of the product under refrigeration.

STRUCTURE, CHEMICAL CONSTITUTION AND LIFE-HISTORY.

What then is an apple? An apple is the much enlarged stalk which once carried the blossom. Its growth has dated from the pollination of the flower. When we come to know it as an article of commerce, it has passed through its youth, has become mature, has separated from its parent and is already on the downward path of old age or senescence. The course of change in form during growth is shown diagramatically in figure 1 which is taken from a paper by Kraus.[27]

As regards the percentage content of various substances present in the fruit at various stages in its life-history, the following is a brief summary of what we find.[28]

The protein content, which is an index of the amount of living protoplasm, reaches a maximum very early. It decreases during growth, but remains

[27] Kraus, E. J. *Oreg. Agric. Coll. Exper. Stat. Bul.*, 1, 1913; 135, 1916; 138, 1916.

[28] Haynes, D. et al. *Ann. of Bot.*, 1925-1928; *Ann. Reports, Food Investigation Board*, 1919-27.

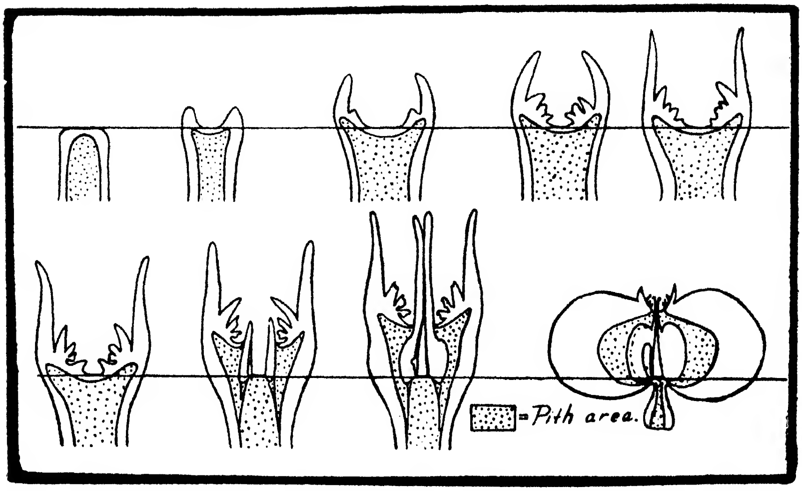


FIG. 1.—Diagram showing development of an apple. Not drawn to scale. (After E. J. Kraus.)

practically constant during storage. The acid content also reaches a maximum at an early date and decreases during growth. The acid content, however, continues to decrease during storage.

The starch content is at a maximum about the middle of the growth period or a little later. There is none in the very young fruit and it has all disappeared again very soon after gathering. The disappearance of starch after it has been formed is due to its transformation into sugars.

There are two main kinds of sugar, (1) cane sugar, a more complex sugar which is chiefly responsible for sweetness, and (2) hexose sugars, which are simpler sugars, principally glucose and laevulose. The percentage content of the apple as regard sugars increases throughout the period of growth on the tree. Cane sugar is at a maximum about the time of maturity and subsequently decreases after gathering by transformation into hexose sugars.

The percentage content of hexose sugars continues to increase during storage, especially if there is much loss of water by evaporation.

You will observe that the flux of change with age may be broadly described as a succession in which complex substances are first formed and later again resolved.

The cell walls bounding the individual living cells of the tissue are intimately concerned in this flux of change. They are built up of cellulose (a substance closely allied to starch) and of substances in the pectin class. After maturation a continuous process of degradation goes on in which these solid substances of the cell walls are resolved into their simpler soluble components. It is this process which gives rise to the softening of the fruit.

The Respiratory System.

A very important feature of the apple is the skin. The skin is relatively impervious to water and gas and becomes increasingly so as the apple matures. It is, however, at all times perforated by minute openings which, in a mature apple, are generally visible to the naked eye as tiny specks which occur more thickly round the " eye " or flower end of the fruit than round the stem end.

Throughout the flesh, between the living cells, is a network of fine air spaces communicating with the external atmosphere through these pores. It is the existence of this fine mesh-work of air channels which gives a slice of apple, when held up to the light, its white opaque appearance. If the air is driven out of these passages and its place taken by liquid, the flesh of the apple becomes translucent. Just the same thing happens as when blotting paper is dipped into water. There is a disease of the apple called water core, and it is a characteristic feature of this disease that the fine mesh-work of intercellular air spaces is filled with fluid so that the flesh becomes translucent.

It is important to note that, in the early stages of growth, the fruit is open to the core from the flower end, and that in some varieties, even when the apple is fully developed, there is still an open way from the core to the exterior (fig. 1).

The impervious skin with its openings, the fine network of intercellular air spaces, and the core cavity which is sometimes open to the exterior, constitute the system by which the oxygen requirements of the living cells are met, and the means by which carbon dioxide given off by each living cell escapes. It is mainly through this system of air channels, also, that water vapour passes to the exterior and the drying and final shrivelling of the fruit result.

When we speak, then, of the respiration of an apple, we mean the consumption of oxygen and the giving off of carbon dioxide by each living cell, with a concomitant evolution of heat and destruction of such substance as sugars and acids in the apple.

The activity of respiration is generally measured in terms of the volume of carbon dioxide given off by a standard weight of fruit in a given time, for example, as cubic feet per ton per day or cubic centimetres per kilogram per hour.

The consumption of oxygen on a volume basis is under most conditions approximately equal to the production of carbon dioxide.

Respiratory Activity and Age.

The activity of this process of respiration in the apple is the next important point for us to consider. It is important in regard to storage because of the heat production associated with it, and because of the modification in the atmosphere of the store which it brings about. It is important also as a primary index of the condition of the fruit, as it changes with time, and its qualities alter as a food product. There are wide differences in respiratory activity

associated with the age of the fruit, the temperature, the oxygen supply and pre-storage factors of race and nutrition.

With regard to age, we find that the respiratory activity of the mature apple is only about a tenth of that of the young fruit early in its growth. There is a steady decrease in activity from the earliest stages onwards. At maturity a change occurs. Respiratory activity rises more or less suddenly to about double its value before the change. This change marks what I have called the climacteric in the life history of the fruit, and is associated with the development of flavour.[29] Subsequent to this change, respiratory activity again decreases in a regular manner until the tissues die. Death is marked by an increase in activity of short duration and then a rapid falling off to zero. Death and cessation of respiratory activity is not related in any obvious way to exhaustion of the sugar and the acid which form the fuel for the process.

RESPIRATORY ACTIVITY AND TEMPERATURE.

My next figure (Fig. 2) shows you the relation between temperature and respiratory activity.[30] This general relation holds at any stage in the life of the apple. The actual values in the figure refer to the stage of maturity. About 12 cubic feet of carbon dioxide per ton of apples are formed per day at 70°F., as compared with about 2.5 cubic feet per ton per day at a cold storage temperature of 35°F.

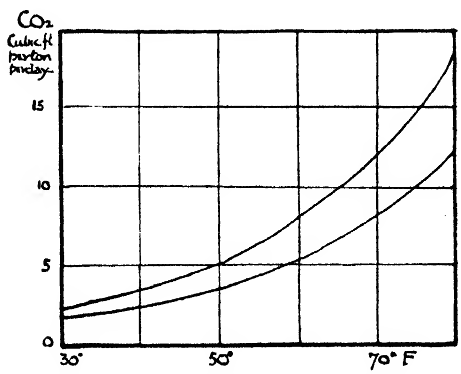


FIG. 2.—Temperature and the rate of carbon dioxide production by mature apples. The two curves indicate the limits between which most varieties under most conditions lie. (After Kidd and West.)

RESPIRATORY ACTIVITY AND OXYGEN SUPPLY.

The relation of the respiratory activity to oxygen supply is complex. At maturity minimum activity is, broadly speaking, with 5 per cent. of oxygen in the external atmosphere, this minimum being about seven-tenths of the normal air value.

[29]Kidd, F., and West, C. *Food Investigation Board, Ann. Report*, 1924.
[30]Kidd, F., and West, C. *Food Investigation Board, Special Report* 20, 1924.

As time passes in storage and as the apple ages, respiratory activity is minimum with progressively higher amounts of oxygen in the external atmosphere until pure air itself containing 21 per cent of oxygen affords the conditions for minimum respiration. At this stage the output of CO_2 will be increased, no matter whether you diminish or whether you augment the amount of oxygen in the atmosphere. With oxygen percentages below those permitting the minimum respiration the character of respiration changes, it becomes less of an oxidation and more of a fermentation. Carbon dioxide is produced without a corresponding uptake of oxygen, as in the fermentation of sugar by yeast.

RESPIRATORY ACTIVITY AND RACE.

Race and nutrition appear to influence respiratory activity throughout the life of the fruit, setting as it were a higher or a lower average pitch. The following, for example, are values found by Gore for the respiratory activity of five different varieties of apples at the time of gathering.[31]

Variety.	*When gathered.*	*Respiratory activity (milligrams* CO_2 *per kilogram-hour at* 32° *F)*	
Jefferis	Mid August	6.3	summer apples
Summer Pearmain	Mid August	6.7	
Yellow Bellflower	Early October	5.9	winter apples
Red Permain	Early October	4.3	
Missouri Pippin	Mid November	4.6	

Summer apples, Gore adds, do not keep as well as winter apples and respire more rapidly.

THE SELF-HEATING OF FRUIT IN BULK.

We have now answered to some extent the query: what is an apple? We know something about its properties and behaviour, and we shall next consider how this knowledge may be important in connection with the storage and transport of the product.

Let me take first the question of heat production. On the basis of a mean value for a number of varieties taken at the time of maturity, it has been calculated that, in the case of an apple cargo from Australia, the heat to be removed in cooling from 70°F. to 35°F. is approximately equal to the total amount of heat subsequently to be removed throughout the voyage, and that the heat being generated by the apples at any time after cooling down is on the average three or four times as great as the heat leaking through the insulated walls from the sea.

These calculations were based on a knowledge of the heat produced in the burning or oxidation of sugar to carbon dioxide and water, which is in effect what occurs in the respiratory process.

[31]Gore, H. C. *U.S. Dept. of Agric., Bur. Chem. Bull.* 142, 1911.

Quite recently the heat given off by apples in storage has been measured by my colleague, Dr. Ezer Griffiths. From Dr. Griffiths' observations it appears that at 20°C. a cubic foot box of apples generates heat at the rate of 0.14 calories per second. Translating this into terms of a ship's hold loading apples, we can say that, assuming an average equipment and a loading temperature of 20°C, something like a tenth of the maximum capacity of the machine is occupied at the outset simply in holding the temperature of the fruit steady, that is, in preventing it rising any higher.[32]

DISASTERS DUE TO SELF-HEATING.

The heat production, consequent on the respiratory activity of fruit, has to be taken into serious consideration in refrigerated transport and storage. As a matter of fact, disasters have occurred in which the power of the refrigerating plant has been insufficient to overcome the heat produced by the material. In this case a vicious circle is established. As the temperature rises so the rate of respiration increases, leading to still greater heat production and a still faster rise in temperature. Under these conditions the insulated walls, which have been so carefully provided, only serve to accelerate this cumulative process, which may result in a total loss. You will realise that the temperature at which the fruit stands when it is loaded into a hold or store must play a determining part in such an extreme case as this, and also that the conditions which will give rise to this vicious cycle occur immediately if there is any breakdown in the machinery producing or distributing refrigeration.

From the following table (after Gore) you will see that the apple is one of the least active of the fruits as regards respiration and heat production. Some of the smaller soft fruits have a far greater respiratory activity, and, as I have already pointed out to you, the activity of the apple itself varies from ten to one as it develops on the tree.

Fruit.	*Respiratory Activity (Milligrams of CO_2 per kilogram hour at 32°F.)*
Blackberry	35
Raspberry	24
Black currant	12
Red currant	5
Peach	12
Plum	6
Strawberry	17
Apple	6
Pear	3

[32] Griffiths, E. *Proc. Phys. Soc.*, 40, 1928.

Self Heating and Uneven Temperatures.

The extreme case we have just dealt with introduces one of the outstanding problems in the refrigeration of fruit and vegetable products to-day—the problem of obtaining uniformity of temperature throughout a large cargo. With the increasing volume of commerce in these articles, economy demands the storing and transport of the largest bulk in the minimum space. Thus lower holds 60 x 60 x 15ft. are now used for the overseas transport of apples, and in such holds the stacked apple cases fill all the available space to the roof. While limited to operating on the surface of this self-heating bulk, how far can we maintain an even temperature throughout the whole stack ?

Cargo Temperature Surveys: (i) Australian.

A few years ago an investigation was undertaken by the Food Investigation Board to find out how effective were the various systems of cooling in vogue with regard to securing uniformity of temperature throughout the bulk of a cargo. The survey was carried out on ships bringing apples from Australia. Three-dimensional maps of the temperatures in all parts of the holds during the voyages were obtained by using distance-reading electrical thermometers distributed throughout the cargo and actually inserted into cases of fruit.[33]

The following illustrations (figures 3 and 4) are an example of what was

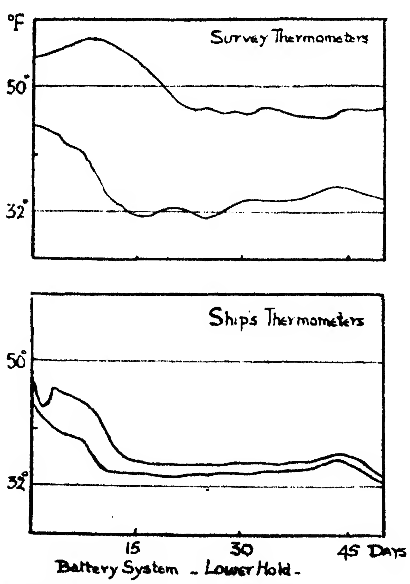


Fig. 3.—Maximum and minimum temperatures in an Australian apple cargo during voyage. (After A. J. Smith.)

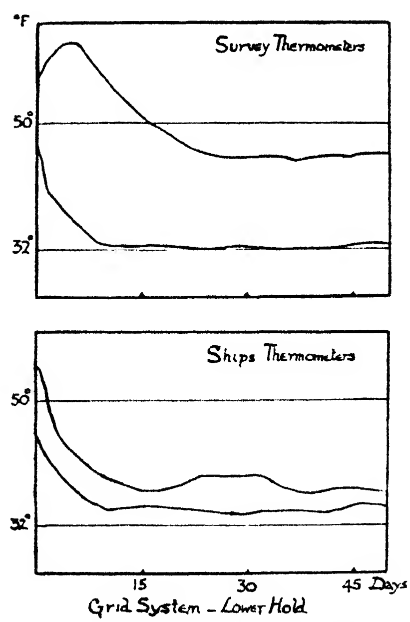


Fig. 4.—Maximum and minimum temperatures in an Australian apple cargo during voyage. (After A. J. Smith.)

[33] *Food Investigation Board, Special Report* 20, 1924; 27, 1926.

discovered. It should be remarked in passing that the ship's thermometers, which are usually situated midway between the sides of the chamber and its centre, tend not to show the extremes of temperature distribution either in the colder or the warmer positions.

The outcome of this investigation was to emphasise three things :—

(1) The striking lack of uniformity of temperature throughout the bulk of the cargo, especially in large holds ; (2) the necessity for powerful fans and rapid air change in the case of the battery system ; (3) and lastly, the general advantage to be gained by cooling as far as possible from the top, and the desirability of providing vertical breaks in the cargo stack.

(ii) SOUTH AFRICAN.

Following these investigations, which were carried out with the co-operation of the shipping companies, some most interesting experiments were made by the scientific staff of the South African Government, again in co-operation with a shipping company.[34]

Within the last decade South Africa has become an important fruit-producing country and a large contributor to the world's sea-borne commerce in fruit. The South African trade is an all-year-round one, oranges during the winter and pears and many varieties of soft fruits during the summer. Accurate control of temperature is of particular importance in the carriage of soft fruits and pears.

In the first place, temperature surveys by distance-reading electrical thermometers were carried out in a small hold with baffled side grids and no forced air circulation. The capacity of this hold was only 6,430 cubic feet and it was only 7ft. 6ins. high. The following temperatures are typical of the distribution found after the first few days :

	Centre.		*Sides.*		
Top	33°F.	42°F.	41°F.	42°F.	38°F.
Middle	35°F.	—	—	—	—
Bottom	33°F.	33°F.	34°F.	33°F.	31°F.

The difference from floor to ceiling varied during the voyage, but, except at the centre, persisted to the extent of at least one degree increase per foot of height to the end of the voyage. The specified temperature for the carriage of the fruit was 34°F. As the result of this survey, adjustments in the baffles were made and some improvement in temperature uniformity thereby obtained.

A similar survey was then carried out in a hold fitted with a battery substitute system, sometimes spoken of as the screened-grid and fan system. The principle of this system will be understood by reference to the illustration (figure 5). The results were summarised as follows :—

"There is a progressive rise in temperature across the hold, the fruit at one side being 14°F. hotter than the other. On reversal of the air current the temperature gradient is reversed and the fruit is subject to an 8°F. fluctuation every

[34] *Union of South Africa, Dept. Agric., Science Bull.*, 56, 1926.

4-6 hours. The difference of temperature from floor to roof is of serious magnitude. The extremes of temperature in this one hold were 27°F. and 45°F." A feature of the system which renders equable control of temperature difficult is the unequal exposure of the circulating air to the cold pipes. The air at the forward end has to traverse the maximum length of cold piping before entering the hold through the ports in the screens.

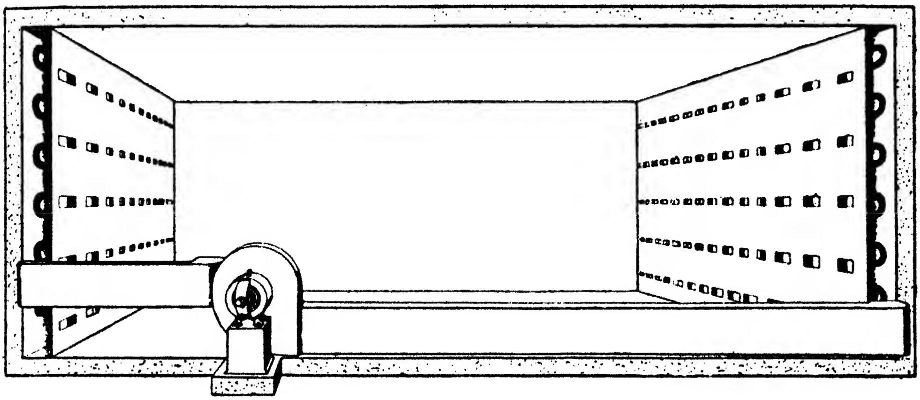


Fig. 5.—Diagram of battery substitute system showing fan, screened grids and ports in the screens. (After Griffiths and Davies.)

Following this survey a modification of the system was introduced and tested by further survey under actual shipping conditions with a full cargo. The ports in the screens were omitted. The air was carried round the sides of the chamber in trunks under the screens, passed thence vertically over the pipes on the walls behind the screens and poured over the top of the screens, being thus delivered at a high level. Improvement was achieved, but the resultant temperatures were still not satisfactorily uniform, owing partly to the fact that the air delivered into the chamber after cooling was still not at a uniform temperature and partly to the fact that on pouring out over the top of the screen the cold air tended to fall.

A further modification was then made. The ports in the screens were again introduced, but, instead of passing the air horizontally across the hold, which is the traditional method both in the screened-grid and in the battery systems, the air of the hold was drawn out on both sides, cooled in its passage over the side grids and then delivered again into the hold by trunks distributed on the roof. By this method the air after cooling was delivered into the hold at a uniform temperature and at points distributed over the top of the cargo. The uniformity of temperature was very appreciably improved, the top and bottom difference being reduced to less than 3°F. at extreme points.

The South African investigators, A. E. Griffiths and R. Davies, who carried out the surveys we have been dealing with, summarise their experience as follows :—

1. Circulation of air is a practical necessity with 'tween deck or lower hold in order to obtain uniform temperature conditions, and this circulation has also very valuable advantages in controlling gas and moisture conditions for a commodity like fruit or eggs.

2. The only sound and reliable system for air circulation is the self-contained battery with sectioning valves. The battery chamber should also be subdivided into two compartments for convenience in thawing off snow deposits, and thawing facilities are essential for fruit ships.

3. Batteries should be in the chambers or holds and not trunked for long distances. A number of small units are in every way preferable to one or two large ones.

4. Air circulation must be adequate; 15 to 20 cubic feet per minute per shipping ton of fruit should be provided, and all fans should be centrifugal multivane type to develop ample flow through closely stowed fruit boxes.

5. Air trunks should be distributed to make the path of the air from delivery to suction through the fruit short, thus avoiding excessive gradient of temperature due to heating up of the air in a long passage through hot fruit.

Delivery over the top of the fruit is strongly recommended and suction should be by a wide trunk around the sides of the hold.

A Bulk-Storage Research Chamber.

There is under construction in this country a large storage chamber to be fitted with special equipment for investigating the various problems connected with the control of temperature, of humidity and of atmospheric composition in the bulk-storage of biological material. I shall not be able to-night to deal with the problems of humidity and atmospheric control, but it is important to realise that these three factors of storage environment are *interdependent variables*. We cannot alter one without affecting the others. It is the interdependence of these variables which, in addition to the complexity introduced by bulk, further complicates the problem. As regards refrigerated stores and ships' holds already in existence, of all sizes and equipped with different types of cooling systems, much may be learned and much improvement effected by the method of survey and adjustment as we have seen.

Temperature and Length of Storage-Life.

From the facts that we have so far examined our interest naturally turns to the question as to the precise extent to which temperature affects the rate of ripening or ageing of fruit in storage. We may again take the apple for the purpose of illustration. In figure 6 is set out a definite quantitative relationship between length of storage life and storage temperature.[35] May I direct your attention to the degree to which relatively small differences in the storage temperature affect the length of storage life. A variation of 1°F. may alter the length of storage life by as much as 10 per cent., while there is very nearly a 100 per cent. difference in effect between a storage temperature of 32°F. and 42°F.

[35] Kidd, F., West, C., and Kidd, M. N. *Food Investigation Board, Special Report* 30, 1927.

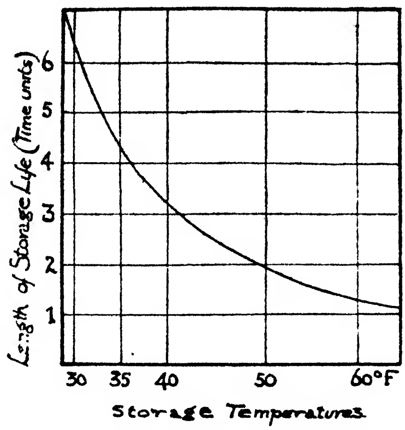


FIG. 6.—(After Kidd, West and Kidd.)

A short explanation of how a general relationship of this sort has been ascertained is of interest. From a limited number of trees, samples, each containing a hundred or so apples, are selected in such a way as to make each sample as nearly identical with every other as possible. A number of these samples are then stored at each of a number of constant temperatures. They are withdrawn at successive intervals and each apple cut and thoroughly examined. From these observations a curve depicting the progress of wastage at each temperature is constructed. One such curve is illustrated in figure 7.[85] The average life of the fruit is the time to 50 per cent. wastage. The commercial life may be defined as the time to 10 per cent. wastage. In this way the storage life at the various storage temperatures can be precisely stated and compared.

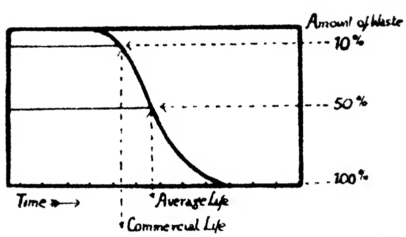


FIG. 7.—Typical curve for the progress of wastage at a constant storage temperature.

BIOLOGICAL VARIATION.

I have dealt with the method employed for determining storage life, because it brings out very clearly an important property of biological material that has to be considered in connection with its storage. I refer to individual variation—the extent to which individual units depart from the mean or average of the

group. Variation will exist in any set of apples not only as regards size, colour, shape, composition, etc., but also as regards the natural term of storage life. From the practical point of view of handling and storing the product, it is of importance to reduce the variation to a minimum. For though two lots of apples may not differ with regard to their average storage life, the lot with the greater range of variation between the individuals has the shorter commercial storage life.

Over-Ripeness and Fungal Rotting.

The end of life in all the cases that we have so far considered is the commencement of rotting arising from fungal infection. Spores of fungal disease are present on the surface of the fruit. For the most part they find their way there before the fruit is gathered. In general, these diseases only attack the fruit when a certain stage of ripeness or over-ripeness is reached. The facts which I have put before you with regard to the relation between temperature and the length of storage life illustrate equally well the relation between temperature and rate of ripening or rate of ageing. Fungal rotting which is not associated with over-ripeness is usually to be traced to surface injuries from rough handling, to physiological disease such as scald, to excessive humidity or to special types of infection.

Low Temperature Breakdown.

Temperature, as we saw in my last lecture, should be expected not only to affect the net speed of the whole complex of changes which underlie ripening and ageing, but also to affect the balance of the various parts in the complex and the composition of the fruit. We found such changes of balance and of chemical composition associated in certain plants with increased capacity to resist frost injury.

The relation between temperature of storage and length of storage life in three different varieties of apple is shown in figure 8. One of the varieties (A) belongs to the class we have already dealt with, in which the length of storage life steadily increases the lower the temperature of the store. In the other two varieties (B and C), you have the surprising result before you, that the length of storage life is only extended by a lowering of temperature down to a certain temperature level. Beyond this, lower temperatures of storage actually shorten the storage life.[36]

In these cases life is ended, not by fungal disease, but by functional breakdown. This breakdown occurs long before the apple shows any signs of over-ripeness. The low temperature has retarded ripening, but it has apparently also upset the balance of the living machine so that complete breakdown and death have occurred.

[36]Kidd, West, and Kidd. *Loc. Cit.*

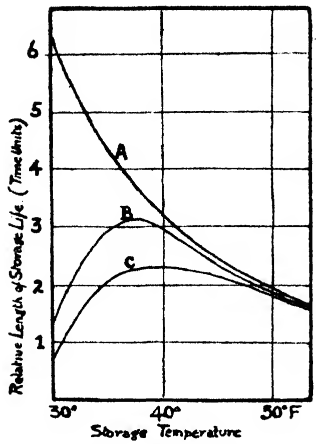


FIG. 8.—Relation between temperature of storage and length of storage life as modified by occurrence of low temperature breakdown in susceptible varieties of apples. Curves C and B are for susceptible varieties; Curve A for a non-susceptible variety. (After Kidd, West and Kidd.)

Breakdown of this sort in apples is known variously as internal browning or internal breakdown, or flesh collapse. It is perhaps better called precisely *Low Temperature Breakdown,* in order to distinguish it from other forms.

Low temperature breakdown is not confined to apples; it is probably common to all fruits in varying degrees. Its visible effects, however, are different in different fruits. Plums, peaches, bananas, oranges, pineapples and tomatoes, all suffer from low temperature breakdown. The experiments of my colleague, Dr. J. Barker with tomatoes may be quoted.[37]

" Experiments with two varieties of tomato, Riverside and Manx Marvel, have shown that they are injuriously affected by storage for more than a short time at temperatures below 50° F. The injury is indicated by failure to develop normal colour and abnormally rapid decay on removal to ordinary temperatures.

Tomatoes kept at 34° F. for four days or less ripened normally at ordinary temperatures, and showed a rate of wastage similar to that of comparable tomatoes which had not been exposed to a low temperature. If, however, the period during which the tomatoes were kept at 34° F. was increased to six or more days, the fruit failed to ripen normally after removal from storage, and an unusually rapid wastage occurred.

Trials with storage temperatures of 34° F., 40° F., 50° F. and 60° F., proved that tomatoes are also injured at 40° F. and 50° F. These results were obtained both with green and fully ripe coloured tomatoes.

It should be noted that the injurious effect of storage at 34° F. is not reflected in the rate of wastage while the fruit is kept at that temperature, but becomes apparent after removal to higher temperatures."

RACE AND STORAGE LIFE.

We have now dealt with two of the forms of wastage which are important in the storage and transport of fruit under refrigeration, namely, over-ripeness

[37]Bark, J. *Food Investigation Board, Ann. Report,* 1927.

associated with fungal rotting, and low temperature breakdown. We have seen how fundamentally important is the temperature factor in regard to both of these. We may next consider the influence of other factors which are under our control, both before storage and during storage.

Let us take first the factor of race. Racial variants within a species are, as I explained last time, fixed and perpetuated in the case of most economic fruits by a process which is essentially nothing more than splitting up the body of the original variant into an indefinite number of racially identical parts. Race variants exhibit very marked differences with regard to inherent keeping quality, rate of ripening and natural term of storage life. The difference between the keeping qualities of different common varieties of apples and pears is so much a matter of common knowledge that one need not enlarge on it here.

Race variants also exhibit, as we have seen, different degrees of susceptibliity to low temperature breakdown.

The practical interest lies in the hope that, with the advent of critical methods of measuring both life duration and susceptibility to low temperature breakdown, progress may be made in the breeding and selection of race variants more suitable than existing ones for the modern requirements of storage and distribution.

Nutrition and Storage Life.

We must not allow ourselves to think that the nutrition of the tree, and of the growing fruit upon it, depends simply upon the soil. From the soil are gathered the requirements of water and mineral salts, including those containing nitrogen. Further, it is upon the physical properties of the soil that the efficiency of the root system of the plant depends. But from the air is gathered the carbon which in various combinations is the major component in the living organism. Finally, from sunlight is gathered the energy which must be absorbed in the process of building up sugars, starches, proteins and such like complex substances from the simpler inorganic food materials upon which the plant subsists.

We class nutritional factors, therefore, under the two main headings—climate and soil. It is not always easy to disentangle their effects.

Climate.

With regard to climate, a good illustration is afforded by the difference between the behaviour of the Yellow Newtown apple from the Pajaro Valley in California and that of the same variety from other regions.[38]

The behaviour of the fruit from Pajaro in cool storage is shown in figure 9. It is definitely susceptible to low temperature breakdown. Elsewhere low temperature breakdown is not known in this variety. The Pajaro Valley

[38] Winkler, A. J. *Journ. Agric. Research*, 24, 1923.

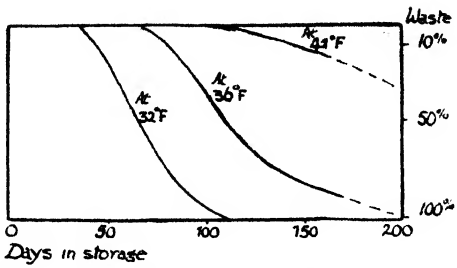


FIG. 9.—Wastage in cold storage from Low Temperature Breakdown in Yellow Newtown apples from the Pajaro Valley district, California Compare the effect of storage at 32° F., 36° F., and 41° F. (After Winkler.)

conditions are characterised by relatively low average temperatures and sunlight, and high humidity.

On a broader basis of comparison we find that New Zealand apples, especially from some regions in the Dominion, are often susceptible to low temperature breakdown. English fruit is also susceptible. The apple crop of the North West of America is not susceptible and can be stored successfully for long periods even at 32°F. The conditions in the North West during the growing season are broadly the reverse of those mentioned above in connection with the Pajaro Valley. They are relatively high temperatures, more sunlight and low humidity.

SOIL.

As to the effect of soil I will give you one example from nearer home. You will notice in figure 10 the great difference in storage life as between fruit grown upon silt soils varying, in the same neighbourhood, from very heavy to very light. These results were obtained by the Food Investigation Board in the course of a joint survey with the Ministry of Agriculture of soil characteristics and fruit keeping quality and chemical composition. This survey has also shown that good keeping quality is associated with the presence of sufficient available potash and phosphoric acid, and the absence of too much nitrogen in the soil.[9]

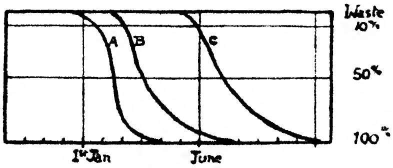


FIG. 10.—Wastage in storage at 34° F. of Bramley's Seedling Apples from (A) light, (B) medium and (C) heavy silt soil. (After Kidd and West.)

[9] Kidd, F., and West, C. *Food Investigation Board, Ann. Report*, 1927.

An elaborate investigation into the effects of climate upon quality has recently been carried out in the United States.[40] The fruit from a hundred different varieties of apples all growing on the same farm has been analysed over a period of six years. Very complete records were kept of sunshine, rainfall and temperature during the growing period of these years. To illustrate the conclusions reached three critical years may be taken, namely, 1923, 1921 and 1924.

In 1923 the total sugar content of the crop was the highest recorded. This year had the most sunshine.

In 1921 the total sugar content ranked second highest for the six years of the investigation. This year had the second highest amount of sunshine and the highest mean summer temperature.

In 1924 the total sugar content was the lowest recorded. This year had the lowest mean summer temperature, and only moderate sunshine.

The 1923 crop was of exceptional high quality as regards colour, size and flavour and stored well. That of 1924 season was markedly inferior in appearance, colour and quality and broke down prematurely in storage.

Maturity and Storage.

We come now to the last of the pre-storage variables with which I shall deal to-day, namely, the stage of maturity at which the fruit is taken from the tree and placed in cool storage. In pursuing this question of maturity we shall meet, and go some way towards understanding, two serious types of wastage which are a source of perennial trouble to the merchant and shipper. I refer to Scald and to a type of breakdown generally known as Jonathan Breakdown, because of its prevalence in the Jonathan variety.

May I recall here the facts that I have put before you as regards the occurrence of a climacteric at the time of maturity, with which is associated a rise in respiratory activity and a concomitant development of flavour and aroma. This climacteric may occur before or after the gathering of the fruit.

Jonathan Breakdown.

With regard to Jonathan Breakdown, Mr. Palmer of the Canadian Experimental Station at Summerland, British Columbia, has, I think, demonstrated clearly that this trouble only occurs if fruit is left too long on the trees. On the basis of his work, a colour standard is now available, by which the proper stage for gathering can be judged as the ground colour of the fruit changes from green to yellow.

Growers are tempted to leave their fruit on the tree too long, in order to get the maximum development of size and of red colour.

This disease, then, is one to which fruit is either definitely predisposed before it enters the store, or to which it is not so predisposed. Predisposed fruit has

[40] Caldwell, J. S. *Journ. Agric. Research*, 36, 1928.

a short life ending in breakdown, sometimes so short that it may even breakdown before it enters the store. With regard to storage temperature, predisposed fruit shows the usual relationship, in that its storage life is prolonged in cold storage. But even so, predisposed fruit cannot compare in length of life with fruit which has not been predisposed.

At this point interesting speculations arise. Is the predisposition to breakdown associated with the occurrence of the climacteric *before* gathering and taking to cool storage. Are the volatile products which develop at the climacteric in any way toxic? May they, if formed in excess of tolerance, so far affect the living machine as to shorten its natural term of life?

To answer these questions fully will require further research, and time also, for the simple reason that we get but one crop of apples a year. Their practical importance is obvious.

A recent observation made in connection with banana ripening is suggestive in relation to the possible effects of volatile products given off during ripening. In the experimental chambers of the United Fruit Company at Boston, fruit under test was consistently found to ripen quicker in one of the rooms. Exploration showed that this room was the most gas tight, and experimental work has now been started to ascertain whether ripening is not definitely accelerated by the volatile products of the fruit itself.[41]

APPLE SCALD.

The last topic to be dealt with to-night is apple scald.

Apple scald was at one time estimated to cause greater losses in the United States than all other storage diseases combined. It consists of a browning of the skin without any softening or browning of the flesh. Fungal rotting usually follows it. This disease also is to be considered in close connection with maturity and the phenomenon of the climacteric. An outstanding fact about it is that restricted ventilation in storage greatly increases its prevalence.

This fact was first established by the experiments of Messrs. Brooks, Cooley and Fisher in the U.S.A.[42] From their discovery these investigators proceeded to an application of the greatest practical importance. It was argued by them that, if ventilation prevented scald, scald should be due to an accumulation of volatile products. Hence, if these products could be absorbed on some material placed round the fruit in store, scald should be prevented.

Many substances were tested and in the end there emerged the oiled apple-wrapper of commerce to-day. This is a wrapper containing approximately 15 per cent. of odourless mineral oil. Its effectiveness in preventing scald is remarkable. A modification of the oiled wrapper is the oiled paper-straw, or oiled shredded paper, which is used as packing material in barrels or boxes.

[41]Committee of Direction of Fruit Marketing, Brisbane. *Official Report of Mr. W. Ranger*, 1928.

[42]Brooks, C., Cooley, J. S., and Fisher, D. F. *Journal Agric. Res.*, 1917, 1918, 1919, 1920, 1923, 1924, etc.

The next important point to observe is that fruit can be predisposed to scald. The effective causal conditions may, apparently, cause a weakening of the living tissue of the skin and a shortening of its natural term of life. It has been found, for instance, that the preventive action of oiled papers occurs during the earlier days in storage, while the fruit is still to all appearance sound. If the wrappers are removed after this, scald is still prevented. Conversely, if the apples are left unwrapped during this early period, but wrapped later on, while still apparently sound, scald is not prevented.

Once fruit has become predisposed, the disease develops more rapidly the higher the temperature. For this reason predisposed fruit taken from cold store will often scald very rapidly.

With so much established, what then are the facts with regard to the effect of the maturity of the fruit at the time it is taken into close pack in storage. Briefly it appears that immature fruit brought into store (i.e., presumably before the climacteric) scalds severely, but if left out in the open for a time (i.e. presumably till the climacteric is passed) and then brought into store, much less scald develops.

Volatile Autotoxins as a Factor in Storage.

It appears possible from what we have seen that volatile autotoxins may be the primary cause both of Scald and Jonathan Breakdown. The occurrence of critical concentrations of these substances in the tissues will depend upon at least three variables, i.e., the stage of maturity, ventilation and temperature. A large field for investigation is opened up here. We have to-day dealt only with the apple, but even in the case of the apple practically nothing of a precise and quantitative nature is known with regard to the nature of the flavour-giving and aroma-giving products: their development in relation to age, race, nutrition and temperature: their specific toxicity in causing breakdown, in predisposing to earlier death, or in predisposing to susceptibility to fungal attack.

Further information on these points would be important, not only from the point of avoiding waste, but also from the point of view of serving the consumer with fruit of the highest flavour and quality.

NOTES ON BOOKS.

The A.B.C. of Flight. By W. Laurence Le Page. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. 7*s.* 6*d.* net.

"The A.B.C. of Flight" was given to the reviewer as a sort of Christmas holiday task, and a very pleasant and instructive one it proved to be, as the author has successfully contrived to get much useful information, in a form readily assimilable by the average person, into a small space.

Mr. Le Page is well known in aeronautical circles in this country and has a really wide experience, which well qualifies him to treat his subject deeply and in considerable detail. This, happily for the average reader, he does not do, but ably shows in simple language that the behaviour of an aeroplane is quite in accordance with natural laws, and that such can be explained without the use of complex formulæ.

The first chapters give an exposition of the main principles of aerodynamics that are required to explain the reasons for the general lay-out of a modern aeroplane as well as those governing its behaviour in the air. Then follow some general but useful particulars showing how machines are constructed and what materials are used.

The process of learning to fly is very fully and clearly dealt with and, finally, this excellent little work is brought to a close with a chapter on the aero-engine and its major accessories.

Mr. Le Page writes mainly from the standpoint of American practice, but this in no way detracts from the value of his work, as divergence is not considerable. Without doubt, all interested in aircraft, including pilots and would-be pilots, can and should take an opportunity of reading this book.

W.S.

Problems of Instinct and Intelligence. By Major R. W. G. Hingston, M.C. London: Edward Arnold and Co. 10s. 6*d*. net.

What is instinct? What is intelligence? Major Hingston prudently abstains from defining them, for, as he says, though many good definitions have been given not one of them is entirely satisfactory. In spite of this, however, every one knows in a general sort of way the difference between the two: instinct works blindly and mechanically; intelligence implies conscious knowledge—a recognition of the relation between cause and effect.

To what extent are animals merely machines? In investigating this problem in the book before us, Major Hingston has restricted himself to the study of insects, because their instincts are so infinitely varied and because they solve many complicated problems in the most perfect way. In doing this, are they nothing but automata? Henri Fabre, who devoted a lifetime to the study of insect life, denied them anything more than an unconscious prompting that has no choice of action. When an insect is carrying out its ordinary avocations, when a bee builds a honey cell with mathematical precision or a spider spins a web with a speed and skill that no human being could rival, it is no doubt actuated purely by instinct; but what happens when an insect is faced by accidents outside its normal experience? Major Hingston made numerous experiments and observations to test them. For instance, he found a pair of beetles (*Gymnopleurus miliaris*) engaged in their usual task of rolling a pellet of dung: "I cut it in half. A terrible calamity! The beetles examine it, survey the two hemispheres. Then they gather the halves together, and press them again into a ball. I cut the ball into four quarters. A still bigger catastrophe! The beetles mould them together again. I alter the shape of their perfect sphere, make one into a cube, flatten another into a disc. It is marvellous to see the beetles' appreciation. I cannot here go into all the details, but they turn both my cube and disc back into the perfect sphere."

Here is another case. "*Myrmecocystus setipes* is a powerful ant. . . It had made a nest on the side of a bank. The ejected earth ran down from it in a shoot, like a landslip on the face of a hill. The shoot was very steep and crumbling, and as

each ant carried out its load, it slipped on the loose material and tumbled down to the bottom of the slope. The ants, however, refused to be defeated. After some days of slipping and falling they managed to devise an ingenious plan of getting over this serious difficulty. They assigned to one particular ant the duty of consolidating and hardening the ground. This ant set about collecting pebbles which it found near the foot of the shoot. These pebbles it carried up the shoot and spread them out in the form of a platform at the very top of the shoot, that is, just outside the mouth of the nest.

" This was tremendous labour for one ant. The carrying of the pebbles up the slippery shoot was a task that lasted several days. It required all the labourer's strength, and caused it innumerable falls. It was interesting to see selection at work. The ant never took the first pebble that offered. Several were examined, picked up and tested, until one was met with that fitted the job. Moreover, it did not place its pebbles haphazard ; it carefully found a suitable spot for the fitting of each load. The final result was a platform of pebbles on which the excavators walked easily, and no more of them fell down the slope. . . .

" I can no more deny intelligence to this act than I can to a man who builds a parapet to prevent people tumbling down a hill."

On another occasion Major Hingston observed a case where a wasp (*Eumenes dimidiatipennis*) had deliberately planned out the whole of her nest before she built it. " One morning, in a deserted house, I happened to see on a whitewashed wall an example of this mason's work. The wasp had completed two of her cells and was about to commence the third. But here is the point which literally amazed me. In addition to the two completed chambers, the wasp had mapped out the scheme of architecture for all the subsequent cells of her nest. Before me on the wall was a definite plan, a mapping out of the final structure, made, I have no doubt, for the same purpose that the human architect maps out a house. . . . . At the very commencement of her labour she had pre-arranged for the whole work. This, I am confident, implies intelligence."

Major Hingston has for seventeen years been a careful observer of animal life in the jungles of the Oriental forests ; he has written a book of absorbing interest to all naturalists, and we think that few will be found to maintain that all the actions of the insects which he describes can be accounted for by blind instinct.

EXACT COLOUR MATCHING AND SPECIFYING. By L. Blin Desbleds. Technological & Industrial Service, 41, Avenue Gambetta, Paris. Price 4*s*.

This short and simply written book deals with the principles of colorimetry and the application of colorimetric measurement to the work of the dyer and colourist. The underlying theory is explained very clearly and in comparatively non-technical language in the first four chapters of the book. Chapter V is devoted to a description of colour measurement by means of the Toussaint photo-electric colorimeter. This is the only instrument described, and unfortunately some misleading statements are made as regards important properties of the photo-electric cell. In the first place it is stated (p.54) that " within the range of use of the apparatus, there is exact proportionality between the light energy acting on the potassium and the change in the intensity of the current in the galvanometer circuit." Later, on p.83, the astonishing statement is made that " the photo-electric cell . . . always reacts in a manner which is exactly proportional to the light energy, *whatever the coloration*, acting upon it." (The italics are the reviewer's). The relative response of the eye to light of different colours is treated at some length in Chapter VIII, but in spite of this the mean of the reflection factors of a coloured surface, measured

at the six wave-lengths, 400, 450, 530, 580, 620 and 700mμ is taken as a measure of the integral reflection factor of the surface, no attention being paid, apparently, to the various visibility factors of lights of these different colours.

From the point of view of the practical dyer, the chapters on colour matching curves and on the fixing of tolerances in colour matching are of the greatest direct importance. The use of colour curves in the correction of mixtures of dyes and in the pre-determination of the mixture required for the production of a specified colour is explained in the final chapters, and these should be of great value to all interested in the subject of dyeing. The printing and production are not as good as could be desired.

J.W.T.W.

GENERAL NOTE.

INTERNATIONAL CONGRESS ON COMMERCIAL EDUCATION.—An International Congress on Commercial Education is to be held in Amsterdam, from the 2nd to the 5th September, 1929. This is being organised by the Dutch National Association for Commercial Education, under the auspices of the International Association for Commercial Education. Business men, educational authorities and governments of about ten countries, including Great Britain, France, Germany, Denmark and China, have promised to send representatives. The task of organising British representation was entrusted to a Committee appointed at a meeting held in London, on November 9th, 1928, at which over thirty members of prominent British organisations connected with commercial education took part. The undermentioned have expressed the hope that Great Britain will be adequately represented at the Congress: The Right Hon. Lord Eustace Percy, The Right Hon. the Lord Mayor of London, Sir John Kynaston Studd, The Right Hon. Lord Southwark, and Sir George Sutton, Bt., Chairman of the Council of the Royal Society of Arts. Those interested in the matter are invited to apply for further information to the Hon. Secretary of the Committee for the Organisation of British Representation, Mr. N. Skene Smith, 5, Onslow Gardens, Wallington, Surrey.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 4..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

Automobile Engineers, Institution of, at the Merchant Venturers' Technical College, Bristol. 6.45 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Dr. A. E. Dunstan, "Petroleum as a Source of Synthetic Material."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. W. R. Rawlings, "Earthing and the Safety of the Public."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. A. Kirkwood Dodds, Presidential Address. "Berwick's Bridges."

Farmers' Club, at the Royal Society of Arts, Adelphi, W.C. 4 p.m. Mr. W. P. Seabrook, "The Economic Side of Fruit Growing."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. J. A. Steers, "The Great Barrier Reef Expedition" (Preliminary Account).

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. H. J. Vaughan, "The Significance of the Timber Merchant in Estate Forestry."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Mr. Philip J. Le Riche, "Scientific Proofs of a Universal Deluge."

University of London, at University College, Gower Street, W.C. 2 p.m. Prof. Edmund G. Gardner, "Dante's Italy."

4.30 p.m. Mr. A. M. Hind, "Rembrandt and other Dutch Etchers and Draughtsmen."

5 p.m. Dr. W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture I.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture IV.)

TUESDAY, FEBRUARY 5..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. N. Colam, "The Regirdering of the Railway Bridge over the Kistna River Madras and Southern Mahratta Railway: Fourteen spans of 150 feet."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

At Lamb's Restaurant, Dundee. 7.30 p.m. Discussion on "Earthed versus Insulated Systems."
At University College, Nottingham. 6.45 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."
Goldsmiths' Hall, Foster Lane, E.C. 7 p.m. Sir Lawrence Weaver, "Art, Industry and Salesmanship."
Hellenic Studies, Scoiety for the Promotion of, Burlington House, W. 5 p.m. Mr. A. H. M. Jones, "Excavations at Jerash (Gerasa) by the British School of Archaeology at Jerusalem and Yale University."
Transport, Institute of, at the Society of Arts Hall, George Street, Edinburgh. 7.30 p.m. Mr. A. H. Roberts, "Discharging of Grain Cargoes at Ports with special reference to the Port of Leith."
At the University, Bristol. 5.40 p.m. Mr. A. S. Quartermaine, "The Relation of Civil Engineering to Transport Problems."
Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.
University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture IV.)
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. A. Meyendorff, "The Social Transformation of Eastern Europe."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. Karl Pearson, "The Current Work of the Biometric and Eugenics Laboratories." (Lecture II.)
8.15 p.m. Miss E. Jefferies Davis, "Historical Factors of the Problem of London Traffic." (Lecture I.)

WEDNESDAY, FEBRUARY 6..Analysts, Society of Public, Burlington House, W. 8 p.m. 1. Dr. T. P. Hilditch and Eveline E. Jones, M.Sc., "The Fatty Acids and Component Glycerides of some New Zealand Butters." Mr. A. Scott Dodd, "A New Test for Boric Acid and Borates." 3. Mr. B. E. Dixon, "The Determination of Beryllium in Rocks."
British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Mr. E. J. Forsdyke, "Minoan Art."
Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Dr. B. Hodgson and Mr. L. S. Harley, "The Development of the Oxide-coated Filament."
Geological Society, Burlington House, W. 5.30 p.m.
Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.
Microscopical Society, 20, Hanover Square, W. Meeting of Biological Section.
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture II.)
University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Kendrick, "English Weavings and Embroideries."
5.30 p.m. Prince D. Soyatopolk Mirsky, "Contemporary Russian Literature." (Lecture IV.)
At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. F. Hutchinson, "Measuring Output in Office Practice (I)."
At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture III.)
5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture IV.)
5.30 p.m. Prof. E. Vermeil, "Les Relations Intellectuelles entre la France et l'Allemagne."
5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture I.)
5.30 p.m. Mr. J. Haantjes, "The Dutch Mediaeval Tale of Beatrice."

THURSDAY, FEBRUARY 7 .Chemical Society, Burlington House, W. 8 p.m. 1. Messrs. C. S. Gibson and J. L. Simonsen, "Indian turpentine from Pinus longifolia Roxb. Part V. The oxidation of d-Δ^3-carene with Beckmann's chromic acid mixture." 2. Mr. A. W. Chapman, "A new method for preparing substituted diphenylamines." 3. Messrs. C. S. Gibson, J. D. A. Johnson and B. Levin, "Compounds of the tryparsamide type. Part I. Resolution of N-phenylalanine-4-arsenic acid and of its amide." 4. Messrs. C. S. Gibson and J. D. A. Johnson, "10-Chloro-5 : 10-dihydrophenarsazine and its derivatives. Part VII. The synthesis of the 1-methyl- and of the 3-methyl-homologues."
Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."
Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Sir William B. Hardy, "Education in Refrigeration."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays" (Lecture II.)
University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Mr. T. A. Joyce, "The Architecture of Central and South America." (Lecture IV.)
At King's College, Strand, W.C. 5.30 p.m. Mr. R. Fitzgibbon Young, "Czechoslovakia." (Lecture IV.)
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture III.)
At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture III.)
5 p.m. Dr. R. H. Ing, "The Chemistry of some Natural Drugs." (Lecture IV.)
5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450—850." (Lecture II.)
5.30 p.m. Prof. Dr. A. F. Pollard, "Cardinal Wolsey." (Lecture V.)
Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Miss C. J. Hudig, "Dutch Silver."

FRIDAY, FEBRUARY 8..Chemical Industry, Society of (Chemical Engineering Group), at the Royal Society of Arts, Adelphi, W.C. 8 p.m. Prof. Dr. W. E. Gibbs, "The Role of Surface Energy in Chemical Engineering."
Geologists' Association, at University College, Gower Street, W. 7.30 p.m. Annual General Meeting. Prof. Dr. A. Morley Davies, Presidential Address on "Faunal Migrations since the Cretaceons."
Malacological Society, at University College, Gower Street, W.C. 6 p.m.
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Discussion on "The Profession of the Mechanical Engineer," introduced by Mr. L. A. Legros.
Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. D. J. MacNaughton, "Electro-Deposition."
At the University, St. George's Square, Sheffield. 7.30 p.m. Mr. W. T. Griffiths, "Some Recent Developments in Nickel Metallurgy."
North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Dr. G. W. Todd, "The Prediction of the Properties of Engineering Materials from their Ultimate Structures."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1. Mr. L. F. Stanley, "The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua." 2. Mr. H. C. Webster, "Photographic Measurement of the Relative Intensities of the LL1, LL2, LL3 Lines of Silver." 3. Mr. H. C. Webster, "Spark Satellites of the LL Lines of Silver." 4. Mr. W. A. Benton, Demonstration of a new instrument for the rapid and accurate determination of the specific gravities of solid substances.
Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. C. E. R. Sherrington, "Recent Problems of Rail Transport at Home and Abroad."
Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Paper by Mr. A. C. W. Imrey.
University of London, at King's College, Strand, W.C. 5.30 p.m. Professor P. N. Ure, "The Age of Justinian as viewed by some of his Contemporaries."
At the London School of Economics, Houghton Street. W.C. 5 p.m. Mr. C. E. R. Sherrington, "Railway Electrification and the Redistribution of Industry."
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture IV.)

SATURDAY, FEBRUARY 9..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. N. Milligan, "Life Beyond the Low-Tide Mark."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. S. Marchant, "Music in Cathedral and Collegiate Churches."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3977. VOL. LXXVII.

FRIDAY, FEBRUARY 8th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK

WEDNESDAY, FEBRUARY 13th, at 8 p.m. (Ordinary Meeting.) CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms in relation to Commercial Fruit Growing" (illustrated by lantern slides). H. V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, will preside.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting in connexion with the Fund for the Preservation of Ancient Cottages will be held in the Hall of the Royal Society of Arts on Wednesday, February 27th, at 3 p.m. THE RT. HON. J. RAMSAY MACDONALD, M.P., will preside.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

THOMAS GRAY MEMORIAL TRUST.

PRIZES FOR THE IMPROVEMENT AND ENCOURAGEMENT OF NAVIGATION.

Under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department).

The objects of the Trust are "The advancement of the Science of Navigation and the Scientific and educational interests of the British Mercantile Marine."

The Council now offer the following Prizes :—

PRIZE FOR AN INVENTION.

(i) A Prize of £150 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the years 1928 and 1929.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at their discretion. Competitors must forward their proofs of claim on or before December 31st, 1929, to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PRIZE FOR AN ESSAY.

(ii) A Prize of £50 for an essay on the following subject :—

"You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semicircle, (*b*) the dangerous semicircle, and (*c*) the direct path of the storm's centre."

Competitors must send in their essays not later than December 31st, 1929, to the Secretary, Royal Society of Arts, at the above address.

The essays must be typed or clearly written. They must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name, which must on no account be written on the essay. A breach of this regulation will result in disqualification.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the Prize or of awarding a smaller Prize or Prizes, if in the opinion of the Judges no suitable invention or essay is submitted.

The Council also reserve an option on the copyright of the successful essay.

NINTH ORDINARY MEETING.

WEDNESDAY, JANUARY 30th, 1929. JAMES SWINBURNE, Esq., F.R.S., in the Chair.

A paper entitled "The Shannon Scheme and its Economic Consequences" was read by MR. GEORGE FLETCHER, M.A., F.G.S., M.R.I.A., late Member of the Water Power Resources (Ireland) Committee. The paper and discussion will be published in the *Journal* on March 8th.

CANTOR LECTURES.

MONDAY, JANUARY 28th, 1929. DR. R. LESSING, Ph.D., F.C.S., in the Chair. DR. C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the last of his course of three lectures on "The Treatment of Coal." On the motion of COL. THE MASTER OF SEMPILL, a vote of thanks was accorded to Dr. Lander for his interesting and instructive course.

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By Franklin Kidd, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

Lecture III.—Refrigeration and Meat.

With an Introduction on Atmosphere Control in Fruit Storage.

(Delivered November 26th, 1928.)

Retrospect.

In my last lecture we dealt with the apple as a type fruit. We saw how a general scientific study of the properties and behaviour of such a food product leads to a better understanding of the conditions to be observed in its storage and transport in bulk as an article of commerce.

Two features of its behaviour were singled out for special attention :—its behaviour as a respiring and heat producing organism, and the occurrence of a critical stage or climacteric in its life history. At this stage a marked increase in respiratory activity occurs and the maximum development of those volatile substances which contribute to flavour and aroma takes place. Some of these substances are definitely toxic to the fruit, so that, in sufficient concentration, they may end or shorten its life.

We considered, in particular, the relation between storage temperature and length of storage life. The conclusion was reached that there is very generally an optimum storage temperature, above which life is shortened by earlier ripening and consequent fungal rotting, and below which death occurs prematurely from functional disorganisation and breakdown of the still unripe fruit. In this connection we reviewed instances of lack of uniformity of temperature in space and time in large storage chambers, and discussed some of the steps which have been taken to improve these conditions.

The broad general principles which emerged from this rapid review are probably applicable in the case of all fruits, but in many cases the quantitative details have yet to be filled in.

Atmosphere Control in Fruit Storage.

There is undoubtedly a relation between respiratory activity and length of life. The faster the respiration, the shorter the life. Racial and nutritional

factors which are associated with long life are also associated with low respiratory activity. One may quote in this connexion the result of a recent experiment in which 120 apples from ten adjacent trees, 12 from each tree, were stored at a uniform temperature, and the respiratory activity and life duration of each determined.[43] You will see from the accompanying table that length of life is associated with low respiratory activity.

Life Class.		No. of Apples	Respiratory Activity, ccs. CO_2 per 10 kh at 12° C.
I	75–94 days	11	62
II	95–134 ,,	27	59
III	135–171 ,,	34	56
IV	172–203 ,,	26	54
V	204–317 ,,	17	51

The questions may then be asked: Are there any storage conditions, other than temperature, which can reduce or intensify respiratory activity?—and will such conditions correspondingly retard or accelerate ripening and ageing?

In answer to the first of these queries, we can say at once there are such conditions. One we have already seen, namely, the oxygen concentration in the air of the store. Lowering oxygen concentration to a certain limit decreases respiratory activity. Beyond this limit further lowering sets up a fermentative type of respiration, the products of which may become injurious. Two others may be mentioned, both related to the atmosphere of the store. Carbon dioxide up to a certain concentration retards respiration and such a gas as ethylen in very small traces accelerates respiration.

The answer to the second query is that each of these factors exercises an effect upon rate of ripening corresponding to its effect upon respiratory activity.

The Use of Ethylene Gas to Accelerate Ripening.

The quantitative aspects of atmosphere control have been as yet only very slightly explored, but one or two examples of its practical application may be quoted.

Citrus. Ethylene gas is now used extensively in the citrus packing houses of California to accelerate the ripening of oranges, which are gathered as soon as a statutory content of sugar and acid is attained, though they may still be green. Early fruit of this sort is needed to extend the marketing season and to avoid excess of supply at the peak period of production. It has long been known that the change from green to orange could be hastened by heating the fruit in poorly ventilated rooms. By using smoking oil stoves, damped down so as to yield products of partial combustion, the change can be further accelerated. This primitive method is now being supplanted by electrical heating and the addition of regulated amounts of ethylene gas to the atmosphere.

[43] Kidd, F. and West, C. *Food Investigation Board, Ann. Report*, 1927.

Chace and Denny, dealing with their researches on the use of ethylene in the colouring of citrus fruits, say:—[44]

"With ordinary gas analysis methods it was not possible to detect the combustion product responsible for the coloration of the fruit, but by a series of experiments it was found that the effective constituent was easily adsorbed by bromine and had a specific gravity about equal to that of air. These facts suggested ethylene, and later experiments showed ethylene to be very effective in bringing about the desired change in the colour of citrus fruit. It is not believed that the ethylene enters into any special chemical combination with the green coloring matter of the fruit to form a colorless compound. The experiments indicate that the ethylene stimulates the fruit to renewed activity, and that as a result of these life activities the fruit itself brings about the decoloration of the green pigment.

It is truly surprising what low concentrations of ethylene are able to cause green fruit to turn yellow. One part by volume of ethylene in one million parts of air was found to colour fruit in about the time required by the older kerosene stove method. Even one part in five million produced a satisfactory result, though it required a longer time.

The high temperatures that were formerly thought to be necessary for the colouring process are now known not only to be unnecessary, but positively injurious. Ethylene will colour lemons with sufficient rapidity for commercial purposes when the temperature is 60° F. to 70° F., and will colour oranges at 70° F. to 80° F. It is possible to obtain coloration at lower temperatures if a longer time is allowed."

Tomatoes. The illustration (Figure 1) shows the acceleration of ripening produced by the action of ethylene gas, and of the allied substance propylene, upon tomatoes. "Ethylene gas in concentrations as low or lower than one in

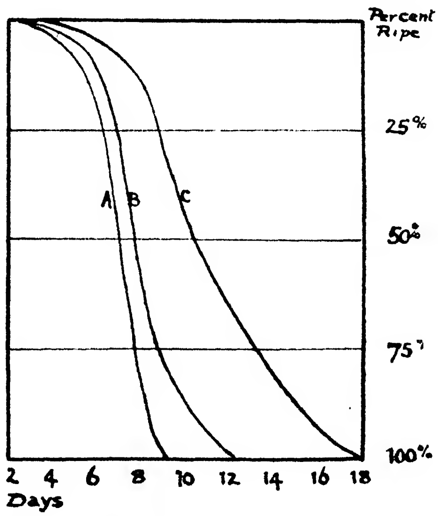


FIG. 1.—The Ripening of Tomatoes. Curve A, one part of propylene to 5,000 of air. Curve B, one part of ethylene to 4,300 of air. Curve C, air alone. (After Rosa).

[44]Chace, E. M., and Denny, F. E. *Indust. and Eng. Chem.*, 16, 1924.

4,300, greatly accelerates the development of the red pigment. Other ripening processes, the destruction of starch and of organic acids, and the conversion of insoluble nitrogen to soluble forms are also accentuated." (Rosa).[45]

Bananas. Similar results are produced by ethylene in the ripening of bananas. Its use, however, has not yet been very generally adopted in connexion with this fruit. The banana fruit is shipped and handled in the green state and ripened or conditioned after arrival in warm rooms. It is interesting to note, however, that the use of exposed gas jets has been considered by the trade superior to hot water pipes for the heating of these ripening rooms, and that in the Botanical Laboratories at Cambridge the amazing oligodynamic effects of extremely small traces of ethylene upon the respiration and ripening of fruit was first discovered, owing to an accidental leak of coal gas (which contains ethylene).

The rate of respiration under the influence of ethylene may be doubled or trebled. In the absence of oxygen the accelerating influence upon ripening and ageing is not observed.

Oxygen and Carbon Dioxide Control to Retard Ripening.

Let us now turn to the other side of the picture and consider briefly the practical application of atmosphere control in retarding ripening by reduced oxygen and increased carbon dioxide.

Effects produced by varying the oxygen and carbon dioxide content of the atmosphere have long been known to botanists, particularly in regard to such activities of the plant as growth, germination and carbon assimilation. Recently a thorough investigation had been begun into the effects of oxygen and carbon dioxide upon the rate of respiration and the ripening of stored fruit.[46]

The upshot to date of this experimental enquiry, which has been carried to the commercial scale and in which the apple has been used, is to show that, either by reducing the oxygen content of the storage atmosphere or increasing the

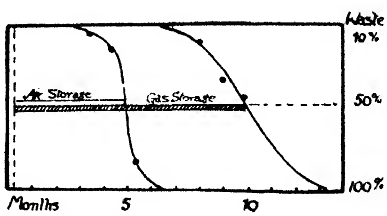


Fig. 2.—Comparative wastage in gas storage and air storage at the same temperature (46.5° F.). Atmosphere in gas storage regulated to contain 9% carbon dioxide and 12% oxygen. (After Kidd, West and Kidd).

[45]Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 23, 1926.

[46]Kidd, F., West, C. and Kidd, M. N. *Gas Storage of Fruit, Food Investigation Board, Special Report*, 30, 1927.

carbon dioxide content, the ripening of the fruit is retarded, and that by combining these conditions effects of very considerable magnitude are produced. The results of a typical experiment are shown in Figure 2. In the controlled atmosphere the storage life is twice that in air. If either oxygen reduction or carbon dioxide accumulation are carried too far injurious results follow.

The required conditions of reduced oxygen content and increased carbon dioxide content can be produced simply by restricting and regulating the ventilation of the storage chambers. With such a method, however, the autotoxic effects of the volatile products of the fruits showed themselves, effects which we have already dealt with. Such effects can be avoided in the case of the apple by the use of oiled wrappers.

Co-ordinate Control of Temperature and Atmosphere Composition Necessary.

An important outcome of this enquiry has been to emphasise the interconnexion between temperature and atmosphere composition in relation to the results produced. Temperature and atmosphere composition are not independent variables. The effects produced by any given atmosphere depend upon the temperature.

Reasons for this interdependence of the two variables, atmosphere and temperature, are not far to seek. On the one hand, gases are more soluble at low temperatures, so that for any given amount of a gas in the atmosphere there will be more actually in solution in the tissue at a low temperature than at a higher one.

On the other hand, with temperature change, the rates of the two processes—passage of gases through the skin, and rate of respiration by the living cells within—are unequally affected. In consequence, for any given oxygen and carbon dioxide content in the *external* atmosphere, the composition of the

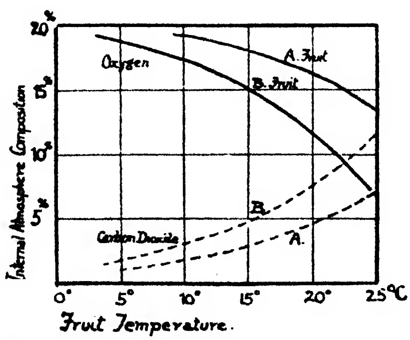


Fig. 3.—Temperature and composition of internal atmosphere of apples. A, fruit is Bramley's seedling from one locality; B, fruit is the same variety from another locality. (After Ekamberam).[46]

internal atmosphere in contact with the living cells within the fruit varies widely according to the temperature of the store. The extent to which this is so will be brought home to you by my next illustration (Figure 3).

At present it appears that optimum results are obtained with regulated oxygen and carbon dioxide atmosphere at temperatures just above the lower limit at which susceptibility to low temperature breakdown commences.

Regulated Ventilation of Ships' Holds.

On what may be called the negative side, this investigation has important practical bearings. We saw in my late lecture the undesirable effects during overseas transport which follow from the self-heating property of fruit due to its respiratory activity.

Our next illustration (Figure 4) shows the extent to which the composition of the atmosphere of certain types of holds may be modified by the activity of the fruit in consuming oxygen and producing carbon dioxide.[47] In these cases, and until quite recently, no attempt was made to regulate this accumulation of carbon dioxide, which therefore always proceeded until the natural leakage from the hold balanced the production of the gas by the fruit.

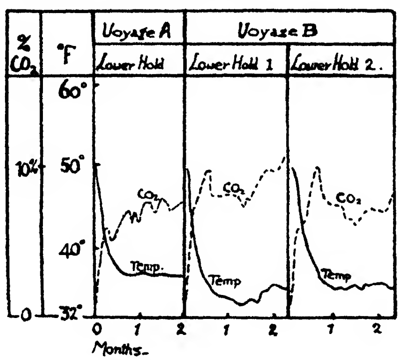


FIG. 4.—Temperature and gas records obtained in unventilated refrigerated holds of the grid type carrying apples from Australia. (After Smith).

From this state of affairs, in conjunction with the inequality of temperature through the cargo already discussed, three consequences may follow, two harmful and one beneficial. Thus, provided the accumulation does not go beyond a certain limit, the portion of the cargo above the temperature associated with low temperature breakdown will benefit. The portion of the cargo below this temperature will be harmed. On the other hand, if too great an accumulation of carbon dioxide occurs the whole cargo will be damaged.

Atmosphere Control Experiment Station.

In concluding this section dealing with atmosphere control, as an auxiliary to temperature control, in the storage of fresh fruit and vegetables, a word

[47] *Food Investigation Board, Special Report* 21, 1925.

of warning may be uttered. We are on new ground and must beware of pitfalls. Temperature variation is a normal factor of environment. We are all traditionally familiar with its broad effects. In controlling atmosphere composition we introduce conditions with which we are not familiar. We shall have to create all our experience artificially and by experiment. For this reason it has been thought desirable to establish an experimental station especially equipped for simultaneous control of temperature and atmosphere composition, and such a station is now in course of erection at East Malling, in Kent.

There is no time here to enlarge further upon this topic, but I think that the broad statements I have been able to make are sufficient to indicate that in atmosphere control we can see the elements of a new and powerful auxiliary means of controlling the forward march of the life processes in the storage of fruits and fresh vegetables.

REFRIGERATION AND MEAT.

We have now to consider animal flesh as a food product, and to discuss some of the principal problems associated with its preservation during the periods of storage and transport which the industrial era have rendered an essential feature in world economy.

Meat in its properties and behaviour differs from fruit and vegetables in many ways. In the first place, it is in a post-mortem state. Though it still possesses a complex organic structure, this structure is in course of irreversible disintegration. Our questions must be, therefore, how does this disintegration proceed, and how may it be regulated either in speed or character by control of temperature or other storage conditions, or by adjustment of the ante-mortem variables of race, age and nutrition or physiological state.

I may perhaps remind you here that some progress in disintegration is generally believed to be desirable for the product to attain its highest quality. The practical problem is, therefore, to handle meat and fish in such a way from the producing centre to the consumer that it may be in its best stage for immediate consumption.

AUTOLYSIS.

Biologists are naturally more interested in the mechanism of the living state than in the sequences of post-mortem decay, but this position is reversed when we begin to study the behaviour and properties of meat in storage. One general feature of post-mortem change can at once be stated. The initial changes that proceed are those activated by the enzyme (or ferment) systems of life, which are disorganised, but not put out of operation by the death of the tissue. Such changes are the hydrolysis (or splitting) of proteins into their simpler components, the soluble amino-acids: the hydrolysis of fats and the splitting of the muscle sugars to lactic acid. These changes are similar to those which occur in digestion, and this type of post-mortem disintegration is known as the autolysis or self-digestion of the tissue.

In the study of the natural course of disintegration of animal flesh there are, of course, the different main types of tissues to be considered—muscle tissue, connective tissue, fat tissue, and gland tissue, so that we again meet (as in the case of plants) the complications introduced by heterogeneity. We often find, for instance, in the storage of meat, that the disintegration of fats giving rise to rancidity may render the product uneatable, while the muscle tissue is still in good condition.

The principles then governing the behaviour of animal tissues and their constituent materials during their post-mortem disintegration form a whole chapter of biochemistry, which is of fundamental importance in relation to the preservation of foodstuffs, but which we have, as yet, hardly begun to explore.

Bacterial and Mould Decay.

With the breakdown of the living state and the onset of post-mortem disintegration, animal flesh becomes at once a rich medium for the growth of bacteria or moulds. The progressive development of these organisms is a secondary complication, and constitutes a field of investigation in itself. The identity of the organisms has to be determined, how they multiply, and the effects they have on the product under various conditions of storage. The interactions between a food product and populations of saprophytic micro-organisms, and the effects of temperature on the same, are of particular interest in connection with the ripening and storage of cheese.

A feature in which such products as meat and fish differ from fruits and vegetables lies in the absence of an intercellular network of air channels. In the living state the essential oxygen is distributed throughout the tissues by the blood stream. After death there is little access of free oxygen to the deeper tissues. This fact has an influence upon bacterial and mould development. Moulds and certain bacteria require oxygen, and are therefore limited to the surface. Other bacteria are able to flourish in the absence of oxygen, and these find their way into the deeper parts of the flesh.

The Freezing and Chilling of Meats.

With this slight introduction let us proceed at once to consider the effect of temperature. It was early discovered without the assistance of science that some forms of flesh, notably mutton, could be frozen hard; handled and stored in the solid condition; and subsequently thawed out, retailed and cooked, without any very marked depreciation in quality. It was also found that other forms, notably beef, were much injured by freezing, juice flowing from the product when it was thawed and its quality after cooking rendered tasteless and dry.

This form of deterioration is so serious that frozen beef has come to be regarded as a low grade article of commerce. For transport and storage of good-quality beef the trade therefore relies on retarding post-mortem disin-

tegration by "chilling," that is, by lowering the temperature without freezing. The storage life in the chilled state is, however, strictly limited, so that chilled beef is a highly perishable article of commerce. Perfected and smooth running organisation is essential for success. Frozen meat, on the other hand, is practically a non-perishable article, and disturbances, such as strikes, wars, or delays in transit, need not necessarily dislocate supplies. The following figures show the relative extent of the trade with the U.K. in chilled and frozen beef:

Country of Origin.	*Quantities.*	
A. FROZEN. (Including Offal).		
U.S.A.	84,569	cwts.
Uruguay	263,455	,,
Argentina	1,447,898	,,
Australia	1,148,978	,,
New Zealand	540,828	,,
Other Countries	100,970	,,
	3,586,698	,,
B. CHILLED.		
Uruguay	700,874	,,
Argentina	8,956,806	,,
Other Countries	20,663	,,
	9,678,343	

ICE FORMATION IN THE TISSUES AND ITS EFFECTS.

The injurious effects of ice formation, which are especially noticeable in the case of beef, thus constitute one of the main problems connected with the cold storage of meats. At the outset it may be recalled that we have already assembled certain generalisations with regard to the nature of the injurious effects produced by ice formation in plants, using as our criterion of injury the death of the organism. We found race, nutrition, and age had a marked influence on the degree of injury caused by ice formation.

We also found that physiological states could be induced by artificial treatment which rendered the organism resistant to freezing injury. And in analysing the cause of injury we isolated a number of factors:—the effects of concentrated salt solutions, such as result when pure water is withdrawn from the system, upon the colloidal organisation of the protoplasm; the protective action of such substances as sugars; the water holding capacity of the colloids against the forces of ice formation; and slow changes occurring in the desiccated system after the separation out of water as ice.

THE MANNER AND POSITION OF ICE FORMATION IN BEEF MUSCLE.

Let us to-night first enquire where and how the ice is formed in the freezing of beef muscle tissue.

The unit in muscle tissue is the muscle fibre surrounded by a limiting membrane, the sarcolemma. These fibres are associated in bundles surrounded by elastic sheaths of connective tissue similar to that which encases the whole muscle. Within the muscle is a network of blood vessels and nerves. From the finest blood vessels a fluid filters out and each fibre is bathed in this. Chemically, muscle consists of 75%-80% of water, 1% of salts, mainly potassium and sodium phosphates and chlorides, 15-20% of proteins. Among other constituents are sugars and nitrogenous bases.

In the living state it is now thought that the fibres contain protoplasm in a liquid or semi-liquid state dispersed through a delicate solid frame work. On death, and during *rigor mortis*, this liquid changes to a gelly with evolution of heat, which is in the order of 1 B.T.U. per lb.[48] Under commercial conditions *rigor mortis* is established before freezing commences.

Ice may be formed both within the fibres or between them. The extent to which this is so, one way or the other, appears in the main to be a function of the rate of cooling. When cooling is rapid the centres of ice formation are extremely numerous and originate within and without the fibres. When it is slow they are few and originate almost exclusively outside, between the fibres, either in the lymph or in the connective tissues.

During freezing the curve of temperature plotted against time flattens out when a temperature of about 1.5°C. has been reached. At this temperature a very considerable portion of the water content of the meat solidifies, and during the process the temperature of the meat does not alter. From 1.5°C. the curve falls slowly to about -3°C., after which the fall becomes more rapid. The flattened part of the curve corresponding to the period in which the bulk of the ice is formed is spoken of as the *thermal arrest*, and its duration is used as a standard by which to compare rates of freezing.

The following Figures—5, 5*a*, and 6—illustrate the way in which ice is formed in beef muscle which has been frozen at various rates. The first of these illustrations shows thin slices of beef as they appear under the microscope at low temperatures, with the ice in them. The second and third show slices cut from pieces of meat in the frozen state and "fixed" before thawing by dropping them into 10% formalin and salt below freezing point. They are thinner sections and show the muscle fibres distinctly, and the degree to which they have been distorted by ice formation. From these illustrations it is clear that, with progressive increase in the rapidity of cooling, we range from a condition in which water and tissue elements become widely separated in space in the frozen state of the tissue to one in which they remain intimately associated. A feature which is well illustrated in one of the microphotos

[48]Smith, E. C. *Food Investigation Board, Ann. Report*, 1927.

in Figure 6 is the fracture of the gelly substance of the individual fibres by the ice crystals. This is a characteristic of fairly rapid freezing.

The details of the experiments of which the results are illustrated in Figures 5 and 5*a* were :—[49]

Figure 5.

I	Freezing medium	Liquid air (-193°C.)	Thermal arrest,	0 minutes.
II	,, ,,	Brine :	,, ,,	24 ,,
III	,, ,,	Brine :	,, ,,	30 ,,
IV	,, ,,	Brine :	,, ,,	60 ,,
V	,, ,,	Brine :	,, ,,	120 ,,
VI	,, ,,	Air :	,, ,,	1200 ,,

Figure 5*a*.

I Same as II above.

II Same as III above.

III Freezing medium, Air : Thermal arrest, 600 minutes.

RATE OF COOLING AND THE "GRAIN" OF ICE FORMATION.

In considering what happens in the formation of ice, we conceive that some degree of super-cooling precedes the formation of ice at each centre of crystallisation. As soon as crystallisation sets in the temperature at that centre and in its immediate neighbourhood rises to the true freezing point, owing to the heat liberated in ice formation.

We may picture, then, that in any system there exist a large number of potential centres of crystallisation which are brought into action by various degrees of super cooling. They vary—that is to say, in regard to what may be called their initial potency. When cooling is slow the few most potent centres get a sufficient start to prevent the other centres becoming operative. The heat release at these few centres balances the slow removal of heat and so prevents further super-cooling anywhere else in the mass. Ice formation is then coarse "grained." When, on the other hand, cooling is rapid, super-cooling may go beyond the point at which the first few centres become operative and so bring other centres into action. This will proceed till again the heat liberated in the more rapid ice formation balances the heat removed in the more rapid cooling. The faster the cooling, the greater the number of centres of crystallisation and the finer the "grain."

Flesh, as we have seen, is a highly heterogeneous system, and it would appear that the interfaces between fibres, or between fibres and interstitial connective tissue, are locations of pre-potency in the initiation of crystallisation.

RATE OF COOLING AND ICE FORMATION IN GELATINE GELLIES.

My colleague, Dr. Moran, has recently made a thorough study of the phenomena of ice formation in gelatine gellies, which constitute a system analo-

[49] Cook, G. A., Love, E. F. J., Vickery, J. R., and Young, W. J. *Australian Journ. Exper. Biology and Med.*, III, 1926.

gous to, though simpler than, muscle tissue [50] Microscopical examinations showed that the number of centres of crystallisation increased as the rate of cooling was increased

With very rapid cooling, *e g*, in liquid air at −193 C the ice formed appears as a fine regular grain of minute spheres about 0 003 millimeters in diameter The masses of desiccated gelatine between the ice are of about the same dimensions as the ice grains

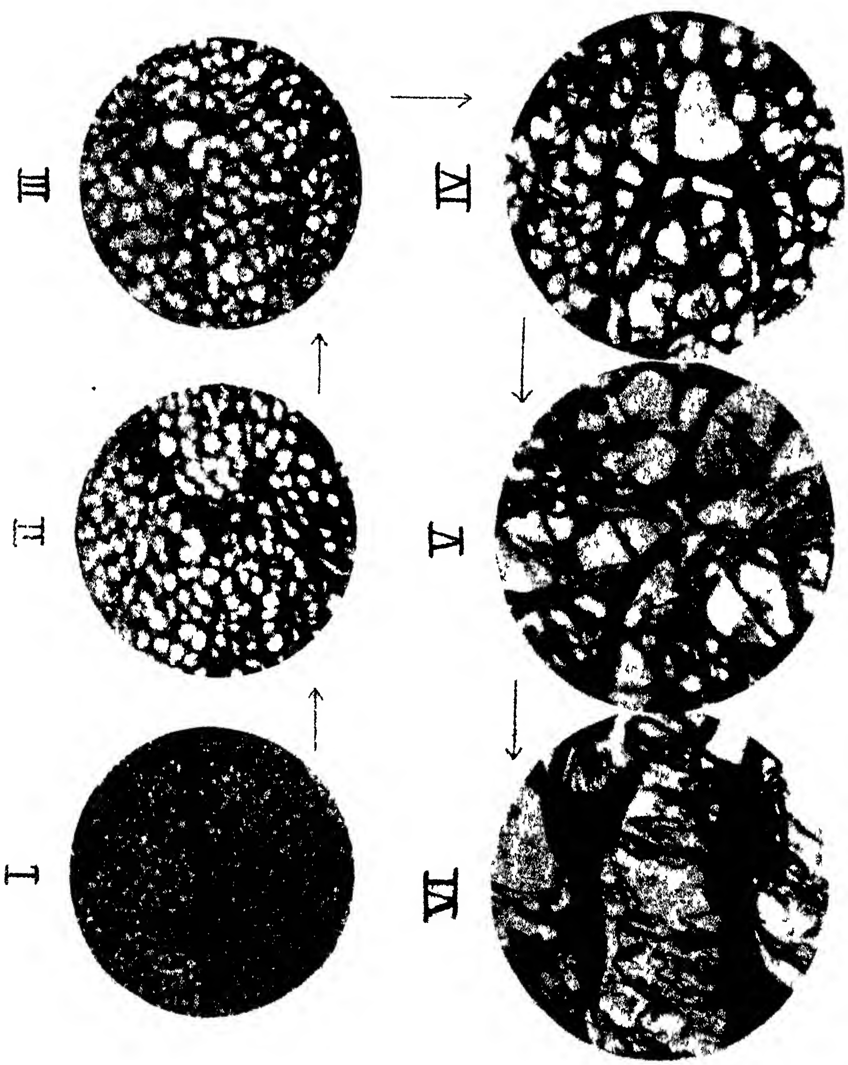


FIG 5 —Thin slices of frozen beef as seen under the microscope in the frozen state Ice white, tissue elements dark Note effect of rate of cooling on degree of spatial separation of ice and tissue elements The most rapidly cooled is No I the most slowly is No VI (After Cook Love Vickery and Young)

[50] Moran, T. *Proc Roy Soc*, 1926 (A) 112, and *Food Investigation Board, Ann Report*, 1924

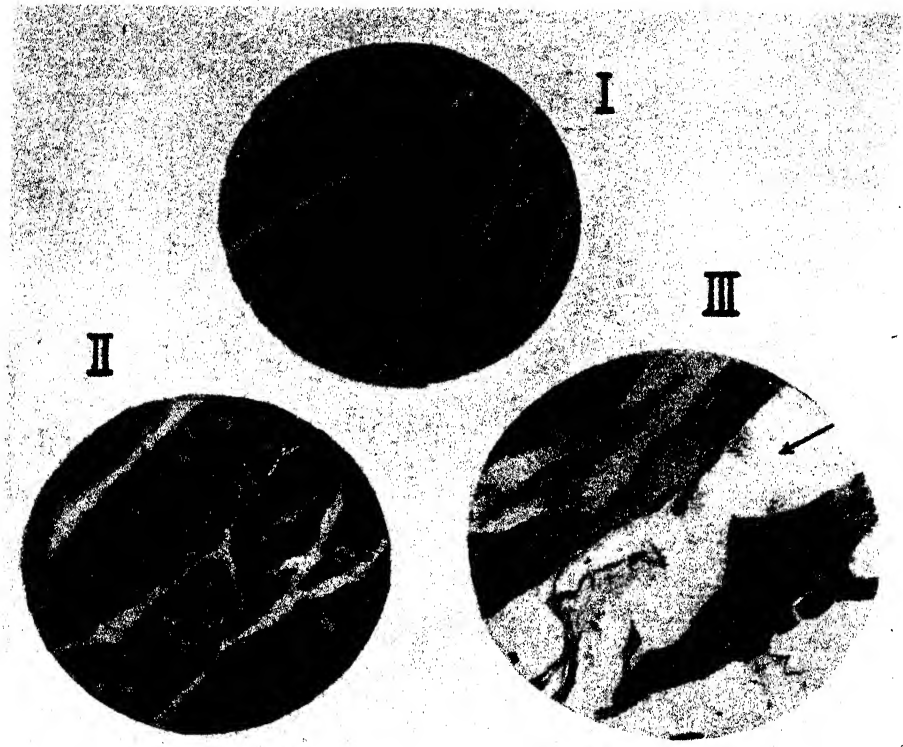
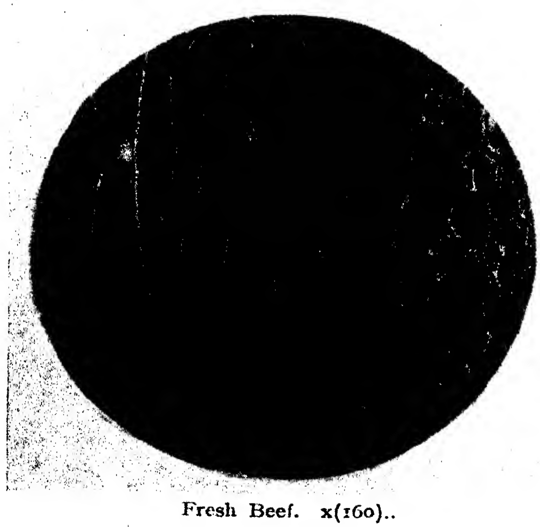
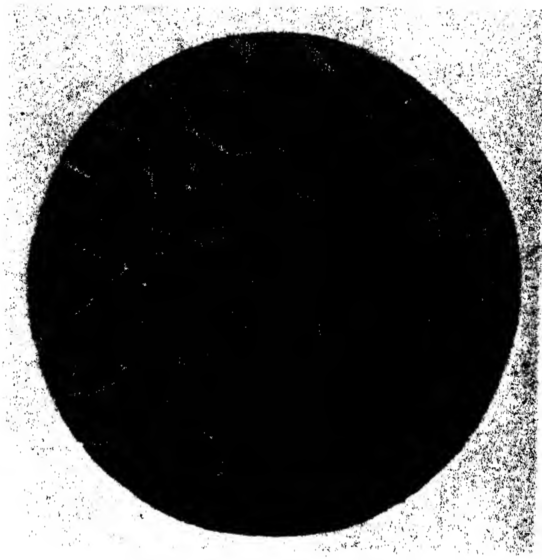


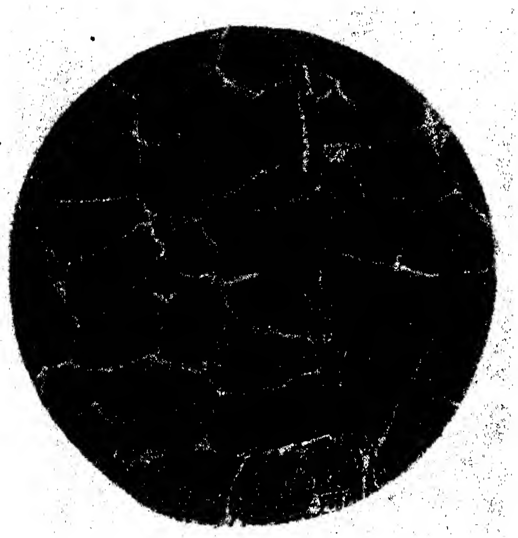
FIG. 5 (a).—Thin slices of beef, which has been "fixed" in the frozen condition, as seen under the microscope after subsequent treatment so as to bring out more clearly the tissue elements. The most rapidly frozen is No. I, the most slowly is No. III. The muscle fibres (dark) have been cut across transversely. Note varying degrees of tissue distortion. The white areas are spaces once occupied by ice. (After Cook, Love, Vickery and Young).



Fresh Beef. x(160)..



Brine Frozen Beef. x(160).



Liquid Air (– 190° C.). Frozen Beef. x(160).

FIG. 6.—(Moran and Hale, unpublished work).

With very slow cooling of small pieces (discs 1.5 cm. x 0 3 cm.) the surface was prepotent as a centre of crystallisation, and the ice formed solely as shell or crust enclosing a core of desiccated gelly.

At intermediate rates of cooling, in addition to surface ice, internal ice is formed, but the centres are relatively few, resulting in irregular masses of

mixed ice and gelly. The ice masses are, as it were, honeycombed by the desiccated gelly strands.

If the gelly frozen is a concentrated one, the irregular honeycombed internal ice masses are replaced by a regular disposition of shells of alternate ice and desiccated gelly disposed concentrically about the original centres of crystallisation. These form very pretty structures. The appearance of one in section, much enlarged under the microscope, is shown in Figure 7. In the same figure is shown a piece of gelatine only very slightly enlarged with these circular ice masses scattered through it.

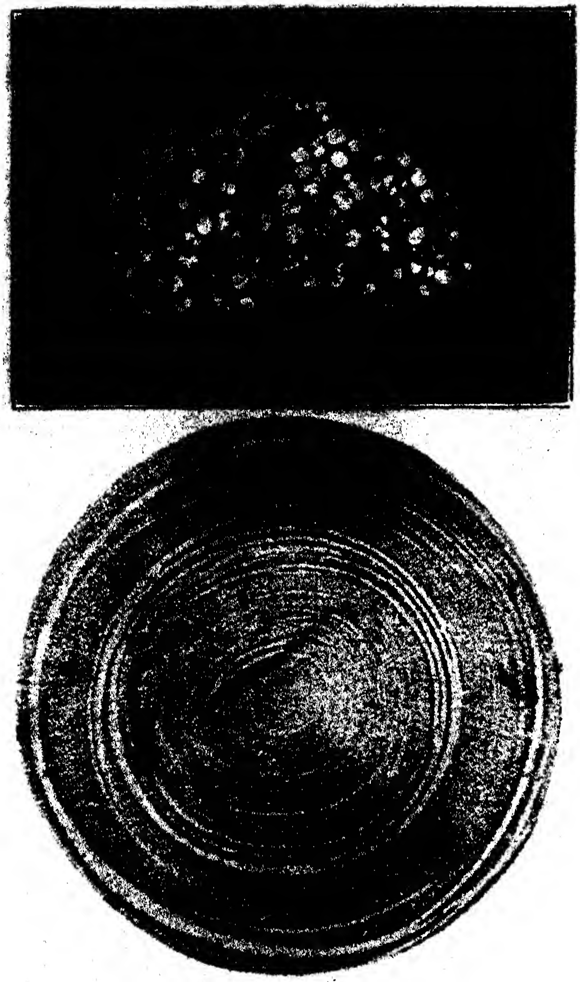


FIG. 7.—Type of ice formation in concentrated gelatine gelly. (After Moran).

FACTORS DETERMINING RATE OF COOLING.

The factors which determine rate of heat transference in cooling are numerous. They are the thermal conductivity, specific heat, density, latent heat, specific surface and nature of surface of the cooled body; and, secondly, the temperature, conductivity, specific heat, density and degree of agitation of the external medium.

A review of the influence of these factors treated on a quantitative basis has been set out by Stiles in one of the special reports (No. 7) of the Food Investigation Board. The most important of them from the practical point of view are the nature of the medium surrounding the body to be cooled, its degree of agitation and the size of the cooling object. I have chosen a few illustrations to remind us of the relative degree of the influence of these factors in particular. (Figures 8, 9, 10).

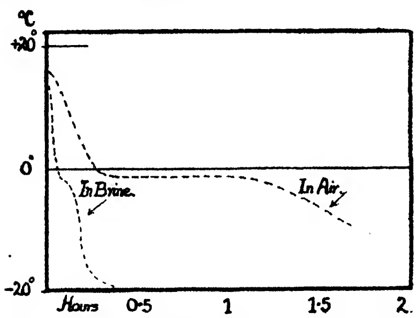


FIG. 8.—Rate of freezing and nature of cooling medium. Curves are temperature records taken at centres of two 15 gram pieces of beef cooled, one in air at —20° C., and the other in brine at —20° C. Thermal conductivity (calories per c.m. per degree per sec.) of brine about 0.001, of air about 0.00005. (After Stiles).

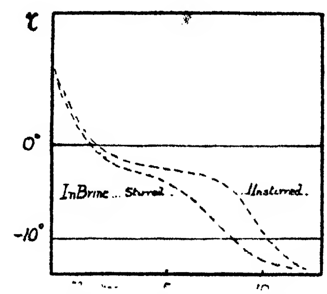


FIG. 9.—Rate of freezing and agitation of cooling medium. Curves are temperature records at centres of two 15 gram pieces of beef, one frozen in brine kept artificially stirred, the other in still brine. (After Stiles).

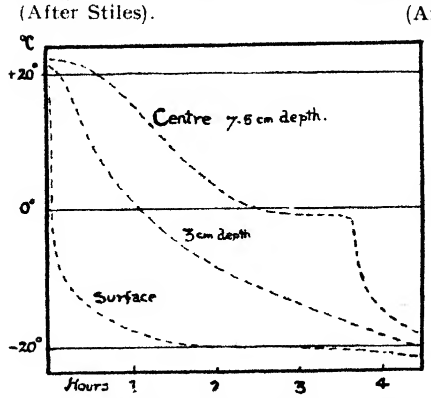


FIG. 10.—Rate of freezing and size. Curves are temperature records taken at different depths in a 15 c.m. cylinder of 5% gelatine. (Adapted from Stiles).

SUBSEQUENT EFFECTS OF DIFFERENT RATES OF FREEZING.

To proceed, let us next enquire how these gradations in the manner of ice formation, which depend on the rate of cooling, influence the subsequent properties of the tissue after thawing. Taking first the quantity of drip, we find that this is progressively greater the slower the freezing and the greater the consequent spatial separation of ice and tissue elements. But we find also that there is much less drip if the thawing is conducted slowly than if it proceeds rapidly. This is what might be expected. Interest attaches rather to the quantitative aspect of the results.

In the first place, then, drip was not entirely eliminated in the experiments which we have been considering and of which you have seen some of the results illustrated (Figures 5 and 5*a*), except in the case in which the tissue was frozen in liquid air. In this case thermal arrest was practically eliminated. One can, however, regard the drip as negligible in those cases in which the thermal arrest was not of more than 0.5 hours duration. If we are to achieve this critical rate in the centres of the freezing masses, the laws of heat flow necessitate that the pieces employed be of the size of small joints rather than of whole sides, and also that freezing be conducted by immersion in an agitated liquid rather than in air.

It has been found, also, that the course and extent of the autolysis of the meat after thawing is greatly modified according to the rate of freezing. We can measure the course of autolysis by estimating the increase with time of the nitrogenous substances in the meat which are non-coagulable by heat, these substances being derived by hydrolytic degradation from proteins. Slow freezing results in a greater and more rapid degradation of the proteins of the meat as compared with that occurring in unfrozen meat. In the case of meat which has been frozen rapidly the course of autolysis after thawing

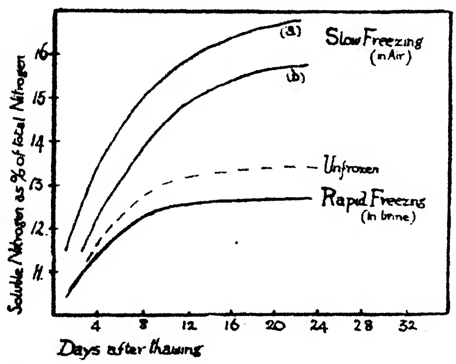


FIG. 11.—Effect of slow (air) freezing and rapid (brine) freezing on autolysis of beef muscle after thawing. (*a*) was frozen directly after killing; (*b*) was exposed for a day at 0° C. before freezing. (After Fearon and Foster).

is not far different from that of fresh unfrozen meat. The illustration (Figure 11) shows the course of autolysis in unfrozen shin beef muscle as compared with that in similar muscle after 24 hours' immersion in brine at –18° C.[51]

RATES OF THAWING AND THEIR EFFECTS.

So much for the effects which have their origin in the rate of freezing and manner of ice formation. Let us next consider, again as far as possible on a quantitative basis, how these effects may be modified by varying rates of thawing. It has been claimed that if the rate of thawing be very slow, drip is eliminated owing to complete reabsorbtion by the tissue of the water and solutes separated out in freezing. This is probably not true. But it is true that reabsorption takes place to a considerable extent and that slow thawing, which prevents the draining away of the thaw liquid by supplying it not faster than it can be reabsorbed, greatly diminishes drip. For example, the following estimations made on small pieces of beef are reported by Cook, Love, Vickery and Young :—

Comparable pairs (a and b), identically frozen.	*Thermal arrest in thawing.*		*Net Drip. Per cent. of fresh Weight.*
a slowly thawed	18	hours	0.7%
b rapidly thawed	2.2	,,	3.7%
a slowly thawed	90	,,	0.8%
b rapidly thawed	4	,,	1.6%
a slowly thawed	54	,,	1.7%
b rapidly thawed	14	,,	3.4%

Microscopical examinations also show clearly that the muscle fibres reabsorb much of the liquid frozen out of them if thawing is slow.

INFLUENCE OF RACIAL AND AGE FACTORS ON FREEZING EFFECTS.

Let us next consider very briefly examples of the influence of race and of age upon the magnitude of these phenomena of tissue distortion by ice formation and of drip on thawing. Generally speaking, with regard to the age of the tissue, it may be said that there is much less drip in the case of the tissue of younger animals. Microscopical examination also reveals the fact that less ice is formed between the fibres.

The same characteristics differentiate mutton and beef. There is less drip from mutton, and also less spatial separation between the tissue elements and the ice formed. For instance, the appearance under the microscope of mutton slowly frozen in air with a thermal arrest of 10 hours (Figure 12) is equivalent to that of beef frozen so rapidly as to show a thermal arrest of only 0.75 hours (Fig. 5, iv).[52]

[51]Fearon, W. R. and Foster, D. L. *Biochem. Journ.*, 16, 1922.
[52]Cook, Love, Vickery and Young. *Loc. Cit.*

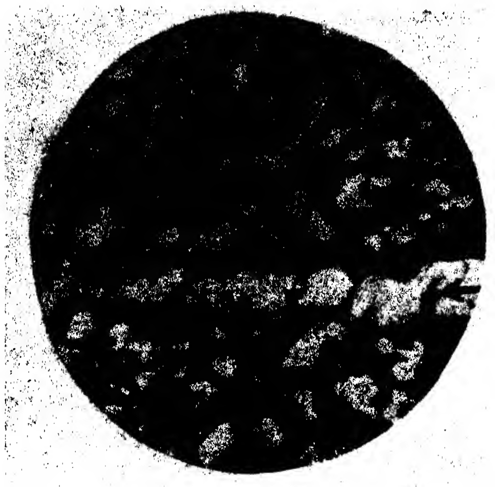


FIG. 12.—Thin slice of slowly frozen mutton (frozen in air at —14° C.) as seen under microscope in frozen state. Thermal arrest 600 minutes. Compare beef similarly frozen (Figure 5, VI, and figure 5 (*a*), III). (After Cook, Love, Vickery and Young).

THE FREEZING OF FISH.

The practical application of the facts we have so far discussed with regard to rapid freezing appears at present to be rather to the handling and storage of fish than to meat. Slow freezing is followed by the same type of undesirable effects in fish as in the case of beef. The majority of fish are units small enough to permit their freezing rapidly enough in agitated brine (NaCl) to avoid these effects.

Experiments have shown that to freeze a fish four inches thick to −7°C. at the backbone takes 37½ hours in air at −7°C., 11 hours in air at −20°C, and only 1¼ hours in brine at −20°C; or to freeze to −20°C at the backbone 15 hours in air as against 1¾ hours in brine at -20°C. The freezing is, therefore, 8 to 10 times as fast in brine as in air.

Incidental difficulties are encountered in freezing fish by this method, one of which is that they may easily freeze together into masses. There is an ingenious device (Figure 13) contrived by my colleague Mr. Piqué for preventing this. The principle of this device is that the fish is frozen in a revolving perforated cylinder immersed in the brine. Inside the cylinder are fitted baffle plates which keep the freezing fish in constant motion as the cylinder revolves, so that they freeze as separate units. The device is suitable for large scale operation on sea or land.[53]

Incidental to freezing by immersion in brine, the surface appearance of meat may be affected. A superficial browning results due to an irreversible

[53]Piqué. J. *Proc. IV Internal Cong. Refrig. I*, 1924.

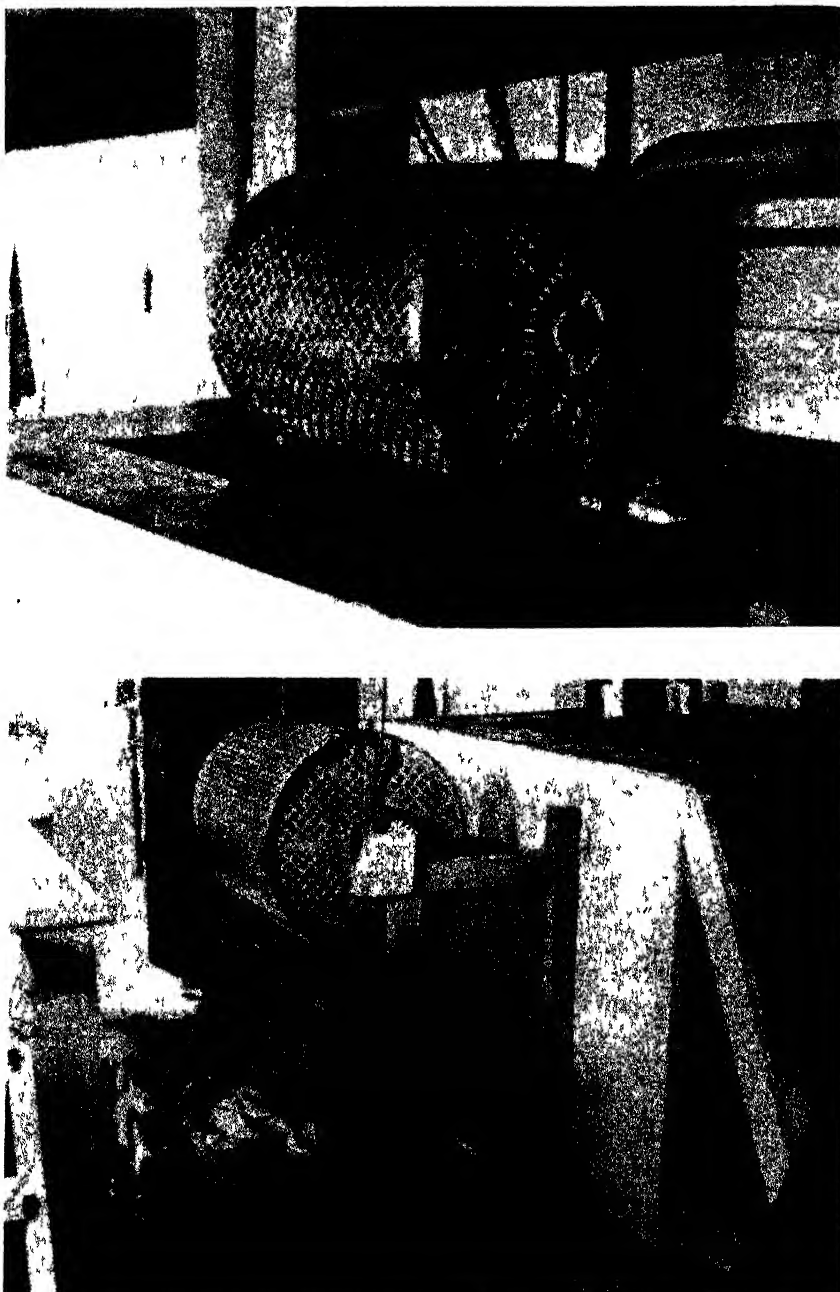


FIG 13.—(After Piqué).

change in the red colouring substance, hæmoglobin to methhæmoglobin. This difficulty can, however, be met by adding a certain percentage of free ammonia to the brine, or by excluding oxygen from the flesh for sometime prior to freezing.

DEPTHS OF FREEZING AND ITS EFFECTS.

We have so far been examining ice formation solely from the point of view of the effect of the *rate of freezing upon the disposition of the ice formed.* Let us shift our point of view and consider *the amount of ice formed at different depths of freezing* and the effect of various factors upon this.

In a simple colloid gelly such as gelatine the amount of water that separates as ice depends upon how low the temperature is. We can speak of freezing to equilibrium at any given temperature—by which we mean that if the gelly is placed at -7°C., for example, a definite quantity of its contained water will freeze and no more. And further, if subsequently the frozen gelly is transferred to a lower temperature, 15°C., for example, a certain further definite quantity of water will freeze; or, reversely, if it is subsequently transferred to a higher temperature, say -5°, a certain definite quantity will thaw and no more, and be reabsorbed by the gelly. The next two illustrations show you how long it takes to reach this equilibrium (Figure 14) and also the amounts of water which are indefinitely retained by the gelly against the force of ice formation at different depths of freezing (Figure 15). It may be noted that beyond a certain point no more water freezes, however low the temperature is taken (within the limits of the experiments), in spite of the fact that there is still much water in the colloid, about 35% in fact.[54]

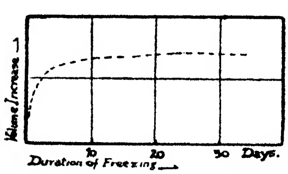


FIG. 14.—Showing time taken to reach equilibrium in freezing at a constant temperature, as indicated by measurement of increase in volume. In the above case of 0.56 grams of a 43.7% gelatine gelly at —11° C., it was 26 days.

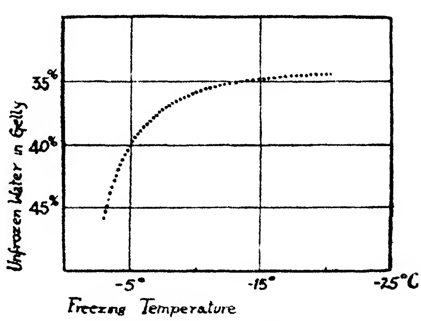


FIG. 15.—Relation between depth of freezing and amount of ice formed at equilibrium in a gelatine gelly. Unfrozen water as % in gelly at equilibrium. (After Moran).

When we turn from gelatine to meat the same phenomenon is encountered, as is illustrated by the following figures (after Plank).[55]

[54]Moran, T. *Loc. Cit.*

[55]Plank, R. *Z. ges. Kalte-Ind.*, 32, 1925.

Temperature.	*Percentage of water present which freezes:*
−1.5°C	42.1%
−2.0	49.7
−3.0	58.3
−5.0	68.0
−10.0	80.2
−15.0	86.7
−20.0	91.0
−30.0	96.2
−45.0	99.5
−55.0	100.0

EFFECT OF ACIDITY ON AMOUNT OF ICE FORMED.

We may notice next that acidity (conc. of H ion) of the gelly considerably affects its water holding power against the force of ice formation. The next illustration (Figure 16) shows how the amount of unfrozen water at equilibrium increases with increased acidity of the gelly.

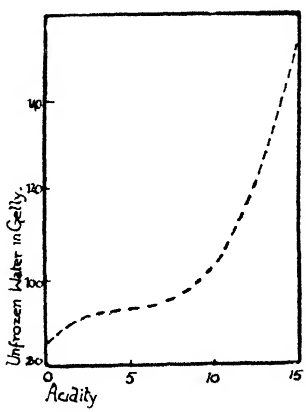


FIG. 16.—The gelatine ice equilibrium curve at —3° C. The acidity units are c.cs. of N/HCl. per 10 grams of dry gelatine. The water unavailable for freezing is expressed as grams per 100 grams of gelatine. (After Moran).

This is of particular interest as we know that lactic acid increases in the muscle after death. We may recall that a period in chill before freezing has been found to diminish the drip from beef after thawing. The following figures from experiments by Cook, Love, Vickery and Young may be quoted :—

Length of time at 1°C. between chilling and freezing.	*Thermal arrest. Freezing.*	*Thawing.*	*Net Drip. Per Cent. of fresh Weight.*
2 hours ...	... 1 hour	1 hour ...	... 5·5
5 days ...	... 1 ,,	1 ,, ...	... 4·7
10 days ...	... 1 ,,	1 ,, ...	... 2.8
15 days ...	... 1 ,,	1 ,, ...	... 4·9
20 days ...	... 1 ,,	1 ,, ...	... 2.2

"Up to the end of ten or eleven days' storage at a temperature of 1°C. before freezing there is a definite decrease in the drip from beef after freezing and thawing. When stored for a longer period a slight increase is observed."

EFFECTS OF DESSICATION, COMPRESSION AND FRACTURE PRODUCED BY ICE FORMATION.

We may proceed now to enquire what effects the drying and compression of gellies, depending on the depth of freezing, may have. That changes do occur in the desiccated gellies when water is forced out of them by freezing we know. The water absorbative power of some gellies is completely destroyed by freezing, so that after thawing their desiccated flakes remain permanently as such. Broadly, the extent to which this happens appears to be a matter of degree as between different substances in the gelly state.

It is unfortunate that we know as yet so much less about the structure of gellies in terms of their molecular organisation than we do about crystals. To illustrate to you the sort of thing that may happen, however, let us consider what happens to gellies in solution when they are frozen. The minute unit-particles of the gelly which are floating freely dispersed, for example, in fresh meat juices or milk, apparently unite into larger aggregates when frozen out by slow ice formation. On thawing, these larger particles persist as such and the quality of the milk or meat juice has been altered.

Vickery has carried out experiments in which he took the press juice from fresh beef muscle and, after freeing it from all particles of gelly big enough to be thrown down by centrifuging, froze the juice at various rates. After thawing, extensive brownish coloured precipitates of a protein appeared, and the thawed juice was full of particles big enough to be thrown down by the centrifuge.[56]

The drying and compression of the gelly following freezing may therefore result in the linking up of smaller aggregate units into larger ones. The concentration effected may also accelerate chemical changes.

Corresponding with varying coarseness in the grain of ice separation must go a varying texture of fracture in the original uniformly coherent gelly. That the separation of ice ruptures a gelly structure irreversibly is shown by an

[56]Vickery, J. R. *Australian Journal Exper. Biol. and Med.*, III, 1926.

interesting experiment carried out by my colleague, Mr. Callow.[57] A supercooled gelatine gelly in a test tube was "seeded" with a crystal of ice at the top and the rate of the downward speed of ice formation noted. This varies with the acidity and concentration of the gelly, etc.

In the present case it was slow—3 centimetres an hour. After freezing was complete the gelly was thawed, then again supercooled, and the experiment repeated. The result was startling. On seeding a second time ice formation *immediately* spread to the bottom of the test tube, following the paths of rupture formed by the original crystallisation. This indicates that, though re-absorption may take place, ruptures in the gelly structure are more permanent.

Depths of Freezing and Effects of Salt Concentration.

So much, then, for irreversible effects produced in pure gellies under the concentrating and compressing effect of ice formation. When we turn to the complexity of tissue, the first major complication that we meet is the presence of salts.

We saw in my first lecture that there was a definite critical depth of freezing in the case of the yolk of eggs. Yolks can be frozen and thawed down to -6°C. without change. If they are frozen below this the yolk changes to the condition found in a soft boiled egg. It is stiff and pasty. This was traced to the action of the salts concentrated in the yolk during ice separation. It may be remarked that this action takes an appreciable time, so that if (and only if) the yolk is frozen extremely rapidly in liquid air at -190°C., and thawed equally rapidly in warm mercury the irreversible effect is avoided.

Freezing and Recovery of Living Muscle.

A most interesting recent discovery in this connection has been made with regard to living muscle--muscle, that is to say, which, though excised from the body, will still contract or twitch in a normal way if stimulated. Such a muscle can be frozen and recover. But there is a critical limit of temperature, corresponding to a critical limit of desiccation, as tested independently without freezing, beyond which death ensues.

The behaviour of living muscle (frog's sartorius) frozen to equilibrium at different temperatures and then placed in water is depicted in the next illustration (Figure 17). The failure to take up water is taken in this case as a criterion of the irreversible death change. This change occurs on the removal of approximately 78% of the water present, either by direct drying, or by freezing to equilibrium at approximately 2°C.

"Chilled" Beef Transport.

At this point interest shifts to the other method of preserving beef during transport and storage; the method known as "chilling," as opposed to

[57] Callow, E. H. *Food Investigation Board, Ann. Report*, 1924.

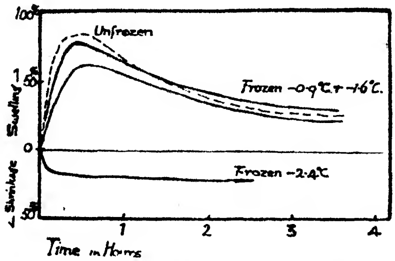


FIG. 17.—The uptake of water by Frog's sartorius muscle. Note marked difference in state of muscle after freezing to —2.4° C., as compared with unfrozen muscle and muscle frozen only to —1.6° C.

freezing. This distinction, in so far as it implies that chilled beef has never contained ice, is a misleading one.

Let me explain. The conditions in the refrigerated holds carrying beef from the Argentine are of great importance and interest. The chambers are cooled by brine circulating in grids on the walls and roofs and there is generally no artificial air circulation.

Temperature distribution surveys, such as I described to you in my last lecture in connection with fruit transport, have not yet been carried out. But the striking fact is that the average temperature maintained, as shown by the ship's thermometers, is about -2°C. This temperature is below the freezing point of beef (*i.e.*, -1°C. av.), and, in fact, much of the chilled meat in the markets contains an appreciable amount of ice.

Digression Concerning Atmospheric Humidity and Its Effects.

Now there is a reason given for this state of affairs which is of some interest. But in the first place a digression will be necessary, in order for us to understand something of another phase of this subject of food preservation, namely, the question of the humidity of the atmosphere and its effects.

In the bulk storage of water-evaporating biological material, the equitable control of humidity throughout the mass presents an even more difficult problem than that due to the heat and gas producing properties of such material. Humidity surveys in commercial stores parallelling the temperature surveys above mentioned, have been begun by my colleague Dr. A. J. M. Smith, and also quantitative work upon evaporation of water from biological surfaces.[58]

As to the effects traceable to the degree of humidity of the storage air, these are two-fold. First the effect upon loss of water and hence of valuable weight; secondly, the effect upon mould growth.[59] In the case of chilled meat the growth or otherwise of moulds on the surface may be said to be largely determined by whether a definite rate of drying of the surface proceeds or not. And in this humidity plays a deciding part.

[58] Smith, A. J. *Food Investigation Board, Ann. Report*, 1927.
[59] Tomkins, R. G. *Food Investigation Board, Ann. Report*, 1927.

Humidity and Temperature in "Chilled" Beef Carriage.

To return, then, to the carriage of Argentine beef. In the closed holds filled with hanging carcasses the humidity is naturally very high. It is reduced by the deposition of snow on the brine pipes. Nevertheless, it is found that the cooling necessary to maintain simple chilling without ice formation is not enough to adequately reduce the humidity of the hold atmosphere. In the formation of ice, heat is liberated, and for the formation of relatively little ice in the meat, the temperature of the pipes can be carried much lower and hence a lower humidity obtained.

If the facts are as stated here, clearly there is much likelihood that portions of the cargo fall to temperatures below the average figure given above, *i.e.*, -2°C., while other portions may be above this temperature. We are led at once to enquire, especially from what we have just seen as to the existence of a critical temperature of –2°C for the living muscle, whether or not any such critical temperature exists for beef.

A Critical Depth of Freezing for Beef.

A recent series of experiments conducted by Dr. Moran at the Low Temperature Research Station at Cambridge, indicate that this is so. Sides of beef were frozen to equilibrium at steady temperatures of –1.5°C, –1.8°C., –2.5°C. After prolonged storage period at these temperatures the meat from –1.5°C. and –1.8°C. showed little or no drip, as compared with that from –2.5°C. Perfect preservation for 60 to 70 days, except for traces of rancidity in the fat, was achieved.[60]

The Transport of "Chilled" Beef from Australia.

During the past three years four experimental shipments of Australian "chilled" beef have arrived in this country. Observations by the staff of the Low Temperature Research Station have been made on the last three of these, after discharge from the ship. The following table (Moran & Vickery)[61]

Shipment	Quantity of Meat.	Length of Journey.	Av. temp. of Chamber as given in ship's log. °F.	Mean loss of Weight Per cent.	Space Occupied per ton of meat. Cub. ft.	Remarks.
1	(*a*) 758 hinds. (*b*) 41 hinds.	55 days 41 days	29–30 29–30	(*a*) 0.88 (*b*) —	108 —	(*a*) Serious mould growth. (*b*) Slight mould growth.
2	298 hinds.	65 days	27	3.2	133	Slight mould growth: meat rather hard owing to ice formation.
3	100 hinds. 60 crops.	48 days 48 days	28.5 28.5	3.35 4.71	144 144	Slight mould growth: Bacterial infection on crops.

[60] *Food Investigation Board, Ann. Report*, 1927.
[61] *Food Investigation Board, Ann. Report*, 1927.

based on these observations and on information supplied by the ship's engineers and the promoters of the shipments summarises the results. Moran and Vickery conclude that " the experiments leave little doubt that *slightly frozen* beef from Australia can be landed in Great Britain in good condition."

From the practical point of view it appears, therefore, that both " chilling " and freezing are feasible as methods of preservation during the transport of beef from the Antipodes. Both have their difficulties and disadvantages, and neither yields, as yet, a first-class product.

If we adopt the freezing alternative, improvement is to be sought by concentrating attention upon pre-storage factors of age, breed, race and nutrition ; upon rate and depth of freezing ; and upon rate of thawing. Quantitative experiments on a semi-commercial scale are needed for the continuous study of the effect of these variables upon quality and drip and in order to put the matter on an *ad hoc* basis of fact. The introduction of new trade methods for the handling of smaller units, which could be more rapidly frozen, would be revolutionary, but by no means inconceivable.

If the chilling alternative is followed, attention must be concentrated on the problems of controlling temperature and humidity to a much higher pitch of accuracy, and in the first place, scientifically conducted temperature and humidity surveys under existing conditions of " chilled " beef transport are called for.

Ice-free Chilled Beef.

Such beef is much desired, because it approximates most closely to the home killed product. It gives no drip. It retains its flavour. It does not sweat so much when removed to ordinary temperatures. Its "bloom" is better preserved, and changes due to the action of deposited water on exposed fat are minimised. The conditions necessary for the transport of ice-free chilled beef are one of the major problems to-day. There are two parts to the problem : to define the conditions of cooling, humidity, air circulation which will control mould growth ; to obtain these conditions when carcasses are hung in bulk in such a way as to utilise as little space as possible.

Conclusion.

While of necessity omitting many aspects, it has been my object in these lectures to give a bird's-eye view of the subject of Refrigeration from the biological point of view, with especial reference to food preservation. In passing, I have been concerned to show how closely fundamental studies of the nature and properties of food products dovetail with practical applications in the industry. The substance of most of the ground covered is provided by the work of the scientific staff of the Food Investigation Board of the Department of Scientific and Industrial Research begun and carried out during the last ten years under the inspiration and leadership of my chief, Sir William Hardy, F.R.S.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock.

February 13.—Cecil Hooper, F.L.S., "The Pollination of Fruit Blossoms in relation to Commercial Fruit Growing." H. V. Taylor, Esq., A.R.C.S., B.Sc., O.B.E., will preside.

February 20.—James Morton (of Morton Sundour Fabrics, Ltd.), "The History of the Development of Fast Dyeing and Dyes." Professor Henry E. Armstrong, LL.D., Ph.D., F.R.S., will preside.

February 27.—A. F. Suter, "East Indian Copals and Damars."

March 6.—Tom Purvis, "Commercial Art." Percy V. Bradshaw, will preside.

March 13.—R. P. G. Denman, A.M.I.E.E. (of the Science Museum, South Kensington), "Loud Speakers." William Henry Eccles, D.Sc., F.R.S., will preside.

March 20.—Professor A. E. Richardson, F.R.I.B.A., "Modern English Architecture."

April 10.—G. H. Nash, C.B.E., European Chief Engineer, International Standard Electric Corporation. "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced :—

P. Morley Horder, F.S.A., "Architectural Models."

Sir Gerald Bellhouse, C.B.E., H.M. Chief Inspector of Factories, Home Office, "Safety in Factories."

J. F. Crowley, D.Sc., B.A., M.I.E.E., "Recent Developments in Vegetable Oil Extraction."

Lady Inglefield, "Lace."

Charles J. Ffoulkes, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts."

Major T. H. Bishop, M.R.C.S., L.R.C.P., D.P.H., "The Purification of Water."

Indian Section.

Friday afternoons, at 4.30 o'clock.

March 8.—W. H. Moreland, C.S.I., C.I.E., "The Indian Peasant in History: an Introduction to the Linlithgow Report." Sir Edward D. Maclagan, K.C.S.I., K.C.I.E., will preside.

April 12.—A. T. Cooper, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

May 10.—P. Johnston-Saint, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.)

Dominions and Colonies Section.

Tuesday afternoons, at 4.30 o'clock.

February 26.—Dr. H. J. van der Byl, Chairman, South African Iron and Steel Industrial Corporation, Ltd., "The South African Iron and Steel Industry." Sir William J. Larke, K.B.E., Director, National Federation of Iron and Steel Manufacturers, will preside.

March 26.—H. Warington Smyth, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa."

SHAW LECTURES.

Monday evenings, at 8 o'clock.

SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, "Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4.

LECTURE I.—THE "LOOKS" OF THE PEOPLE. Advantages of a disengaged eye occasionally in the Factory—A help in determining success or otherwise of Welfare arrangements—Classification of "looks" in women—Results—Difficulty of classifying "looks" in men owing to the interest excited by the absorbing nature of their work—Australian men of a pre-eminently handsome type.

LECTURE II.—THIRTY YEARS' EXPERIENCE OF THE NOTIFICATION OF INDUSTRIAL DISEASES. The eleven notifiable diseases and forms of poisoning—Results obtained in disappearance of some, diminution of others and stationary conditions of yet others again—Reasons for this in the remedial measures applied—Dominance of lead poisoning, anthrax and skin cancer.

LECTURE III.—TWENTY YEARS' EXPERIENCE OF COMPENSATION FOR INDUSTRIAL DISEASES. The wide net of the Compensation Act—Twenty-eight diseases and forms of poisoning scheduled—Reasons for exclusion of some—Results obtained as shown in the chart—Dominance of miners' maladies—Increase in dermatitis—Increasing importance of silicosis and help given by the action of the South African Government in dealing with it.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic movements in Asia." Four Lectures: April 15, 22, 29, and May 6.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 11..African Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Mr. T. A. Barns, "Through Portuguese West Africa."

Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Brewing, Institute of, at the Charing Cross Station Hotel, Strand, W.C. 7.45 p.m. Dr. S. B. Schryver, "The Proteins and their Importance in Brewing Theory and Practice."

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr. Frank Birdwood, "The Indian Coastal Traffic Bill."

Electrical Association for Women, at 15, Savoy Street, W.C. 7 p.m. Mr. H. de A. Donisthorpe, "Radio Progress and its Connection with the Thermionic Valve."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Geographical Society, at Lowther Lodge, Kensington Gore, S.W. 5 p.m. Captain E. R. L. Peake, "The Tavistock Theodolite."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. G. S. Szlumper, "Cross Channel Traffic Working."

University of London, at University College, Gower Street, W.C. 2 p.m. Miss M. St. Clair Byrne, "Elizabethan England."

5 p.m. Dr. W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture II.)

5.30 p.m. Prof. J. G. Anderson, "Archæological Research in China." (Lecture I.)

5.30 p.m. Dr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture I.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture V.)

TUESDAY, FEBRUARY 12..Asiatic Society, 74, Grosvenor Street, S.W. 4 p.m. Dr. L. D. Barnett, "The Genius: A Study in Indo-European Psychology."

Automobile Engineers, Institution of, at the Rover Sports Club, Coventry. 7.30 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

At the Royal Technical College, Glasgow. 7.30 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Empire Society, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Percy Cox, "Iraq."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. G. J. Scott, "The Design and Construction of Electric Auxiliaries for Marine Service."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. J. E. Newson, "Metallurgy of Engineering."

North East Coast, Institution of Engineers and Shipbuilders, at Cleveland Institute, Middlesbrough. 7.30 p.m. Mr. G. B. Butler, "The Manufacture of Steel as Applied to Shipbuilding and Engineering."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Messrs. J. S. Parker and C. A. P. Southwell, "Chemical

Investigation of Trinidad Well Waters and its Geological and Economic Significance."

Philosophical Studies, Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. L. Susan Stebbing, "Is 'Good' Objective?"

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture III.)

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture V.)
5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Motors."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Mr. F. L. Engledow, "Plant Breeding." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. G. M. Morant, "The Current Work of the Biometric and Eugenics Laboratories." (Lecture III.)
8.15 p.m. Miss E. Jeffries Davis, "Historical Factors of the Problem of London Traffic." (Lecture II.)

WEDNESDAY, FEBRUARY 13..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. P. Gaze, "Merits of Alternative Methods of Driving Auxiliaries in Modern Power Stations."

Fuel, Institute of, Burlington House, W. 6 p.m. Mr. W. F. Goodrich, "Fuel Economy and the Small Steam User."

Heating and Ventilating Engineers, Institution of, at the Holborn Restaurant, W.C. 2.30 p.m. Ordinary Meeting. Mr. H. G. Cathcart, "Water Softening by the Base Exchange Process."

Mechanical Engineers, Institution of, at the Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture.)

Metals, Institute of, at Thomas' Café, Swansea. 7 p.m. Mr. J. E. Malam, "Recent Developments in Rolling Metal Strip and Sheet."

North-East Coast, Institution of Engineers and Shipbuilders, at Belbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. F. H. Todd, "Ship Trials and their Analysis."

United Service Institution, Whitehall, S.W. 3 p.m. Mr. J. M. Keynes, "National Finance in War."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. W. J. Constable, "English Painting."
5.30 p.m. Prince D. Svyatopolk, "Contemporary Russian Literature, 1917-1928." (Lecture V.)
(London School of Economics), at Chesham House, 136, Regent Street, W. 6 p.m. Mr. R. Horrocks, "Nominal Ledgers and Managerial Statements."
At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture IV.)
5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture V.)
5.30 p.m. Prof. J. G. Anderson, "Archæological Research in China." (Lecture II.)
5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture II.)
5.30 p.m. Mr. B. M. Headicar, "A Bibliography of Political Economy, Methods of Construction and Plans for keeping up-to-date."

THURSDAY, FEBRUARY 14..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.45 p.m. Mr. A. H. R. Fedden, "Air-Cooled Engines in Service." (Joint Meeting with Institution of Automobile Engineers.)

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. W. Cruickshank, "Voice-Frequency Telegraphs."
At University College, Dundee. 7.30 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Historical Society, 22, Russell Square, W.C. 5 p.m. Anniversary Meeting.

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Shoreditch, E. 7.30 p.m. Mr. A. Stratton, "Tudor Houses."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture.)

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. "Some Present-day Metallurgical Tools." (1) Dr. C. J. Smithells, "The X-Ray Spectrometer"; (2) Mr. S. V. Williams, "Quantitative Spectroscope Analysis"; (3) Mr. H. Wrighton, "High Magnification Microscopy"; (4) Mr. W. E. Prytherch, "Dilatometers"; (5) Mr. A. J. Murphy, "Preparation of some Unusual Metallographic Specimens."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Dr. W. Rosenhain, "Alloys: Past, Present and Future."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays Lecture III.)

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. "Architecture and its Relation to National Life—(Lecture V) on "Egyptian Architecture."
At King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture I.)
5.30 p.m. Mr. Ifor Evans, "Czechoslovakia" (Lecture V) "The Economic and Financial Problems of the Republic."
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Mr. F. L. Engledow, "Plant Breeding." (Lecture II.)
At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture IV.)
5 p.m. Mr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture V.)
5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450-850." (Lecture III.)

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Prof. F. W. Hudig, "Delft Pottery."

FRIDAY, FEBRUARY 15..Electrical Development Association, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. H. W. Roberts, "Organising for Increased Sales—Spring Cleaning Season, 1929."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Lt.-Colonel Vaughan-Morgan, "Open Spaces and Playing Fields for London."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Annual General Meeting. Mr. H. J. Ward, "Refrigeration on Shipboard."

Oil and Colour Chemists' Association, at Milton Hall, Manchester, 7.30 p.m. Mr. F. Scholefield, "Ostwald's Colour System."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Dr. Eric K. Rideal, "Chemiluminescence."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. C. Douglas Campbell, "Inland Water Transport."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Henry Thomas, "The Pass, the Battle and the Monastery of Roncevaux."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. C. E. R. Sherrington, "Motor Transport and the Urbanisation of the Countryside."
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture V.)
5.30 p.m. Prof. J. G. Anderson, "Archæological Research in China." (Lecture III.)
5.30 p.m. Mr. Geoffrey Peto, "The Local Government Reform Scheme and De-Rating."

SATURDAY, FEBRUARY 16..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss I. D. Thornley, "Travel and Travellers in the Middle Ages."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Bullock, "Music in Cathedral and Collegiate Churches. (Lecture II.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3978. VOL. LXXVII.

FRIDAY, FEBRUARY 15th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 18th, at 8 p.m. (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, "Thirty Years' Experience of Industrial Maladies." (Lecture I.)

WEDNESDAY, FEBRUARY 20th, at 8 p.m. (Ordinary Meeting.) JAMES MORTON (of Morton Sundour Fabrics, Ltd.), "The History of the Development of Fast Dyeing and Dyes." PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., will preside.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting in connexion with the Fund for the Preservation of Ancient Cottages will be held in the Hall of the Royal Society of Arts on Wednesday, February 27th, at 3 p.m. THE RT. HON. J. RAMSAY MACDONALD, M.P., will preside, and the speakers will include MR. G. K. CHESTERTON, LIEUT-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., SIR GEORGE SUTTON, BT., Chairman of the Council, and others.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

COMPETITION OF INDUSTRIAL DESIGNS.

The sixth annual Open Competition of Industrial Designs will be held in June next, and full particulars can now be obtained on application to the Secretary of the Royal Society of Arts.

Over £2,000 will be offered in prizes and scholarships in the various sections, distributed as follows :—Architectural Decoration, £365 15*s.* ; Textiles, £704; Furniture, £145 ; Book Production, £73 10*s.* ; Pottery and Glass, £52 10*s.* ;

Advertising (Posters, Showcards, etc.), £699 2s. The Art Congress Studentship, of the value of £50, is also offered and may be awarded at the discretion of the Judges in any section of the competition.

After the work has been judged a number of selected designs will be exhibited in London, and subsequently at suitable centres in the provinces. In this way they will be brought immediately to the notice of those manufacturers who are likely to be specially interested in them.

It is intended to confer the Society's Diploma on any candidate whose work reaches a very high standard of artistic ability and also shows practical knowledge of the materials and processes of his trade.

A Bureau of Information has been established at the Royal Society of Arts for the registration of the names and addresses of exhibitors who desire to obtain employment as designers. These lists are at the service of manufacturers in search of designers.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 6th, 1929. E. F. C. TRENCH, ESQ., C.B.E., M.Inst.C.E., Consulting Engineer to the L.M. & S. Railway, in the Chair.

The Trueman Wood Lecture was delivered by SIR J. ALFRED EWING, K.C.B., LL.D., D.Sc., F.R.S., M.Inst.C.E., Principal and Vice-Chancellor of the University of Edinburgh and Chairman of the Bridge Stress Committee, on "The Vibration of Railway Bridges: An Example of Co-operative Research." The lecture will be published in the *Journal* on March 15th.

INDIAN SECTION.

FRIDAY, FEBRUARY 8th, 1929. VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, late Commander-in-Chief, East Indies Squadron, in the Chair.

A paper on "The History of the Indian Marine" was read by CAPTAIN SIR EDWARD J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., late Director the Royal Indian Marine. The paper and discussion will be published in the *Journal* dated March 22nd.

CANTOR LECTURES.

The Cantor Lectures on "Acoustics," by Mr. A. G. Huntley, of the May Construction Company, Ltd., are available in pamphlet form (price 2s. 6d.), and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can also be had on application.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

WEDNESDAY, 16th JANUARY, 1929.

DR. MARGARET FISHENDEN, D.Sc., F.Inst.P. (Fuel Research Division, Department of Scientific and Industrial Research), in the Chair.

THE CHAIRMAN, in introducing the lecturer, said that Professor Darling was going to speak on a problem which very few, in this industrial age, were fortunate enough to be able to avoid, namely, smoke. There were many objections to smoke, but perhaps the strongest one was that it was so unpleasant. For that reason alone any suggestions Professor Darling might have to put forward would be listened to with attention.

The following paper was then read :-

THE DOMESTIC SMOKE PROBLEM—A PRACTICAL SOLUTION.

By PROFESSOR CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., F.INST.P.

The smoky atmosphere of London has been a reproach for centuries. Writers from the time of Queen Elizabeth have vied with each other in describing the evil effects of smoke on the health of the inhabitants and on buildings, but it is only in recent years that any mitigation of the nuisance has been witnessed. This improvement has been due to two chief causes—the adoption of more efficient furnaces for manufacturing purposes and the introduction of smokeless appliances for domestic use, such as gas fires, electric radiators, anthracite stoves and coke-fired boilers. It is estimated that five-sixths of the smoke discharged into the atmosphere of London is of domestic origin, and it therefore follows that the prevention of smoke is mainly a domestic problem. Yet, in spite of all the contrivances named, the output of smoke is almost as great as ever. During the last ten years upwards of 180,000 new houses have been erected in the metropolitan area, each being a potential producer of smoke. The consumption of coal for household purposes in the London area is estimated at eight million tons per annum, only a small percentage of which is represented by anthracite or smokeless coal. The same state of things prevails in other large centres of population throughout the country—new houses and more smoke—the total consumption of household coal being about thirty-six million tons per annum.

In trying to find a remedy it is first of all necessary to enquire into the reasons why household coal is still so extensively used, although domestic appliances for producing heat without smoke have been available for many years. The two chief reasons are that hitherto no alternative to the coal fire has been discovered at once so cheap and generally useful, and, secondly, even in cases

where the question of cost may be discarded, there is an ingrained preference on the part of the average person for an open coal fire, which gives to a room a sense of comfort and cheerfulness. In the latter connection it is interesting to note that modern hotels, fitted with central-heating apparatus and all the latest devices, advertise "a coal fire in the lounge." G. K. Chesterton describes the coal fire as "the veritable flame of England, still kept burning in the midst of a mean civilisation of stoves." The only hope of curing the smoke nuisance lies in the production of a substitute which, whilst retaining all these desirable features, does not give rise to smoke and is as cheap or cheaper to maintain. It is the purpose of the present Paper to endeavour to show that such an alternative is to hand and that the domestic smoke problem may definitely be solved.

Before entering into the question of remedies it is necessary to consider the part played by the coal fire in the homes of different sections of the community. A very large proportion of the dwelling-houses in large centres of population are small, containing five to eight rooms, and the occupants in most cases cannot afford to use heating devices which are costly to buy or maintain. In the smallest of these the kitchen is frequently the living room, and the coal fire, in addition to warming the room, is used for heating water, cooking, and other domestic operations, including the drying of the family washing in wet weather. Domestic refuse is—or should be—burnt on it, and it is this general utility, combined with cheapness, which explains its continued use in spite of rivals. In the seven or eight-roomed house the "reception" room usually occupied contains a coal fire for the reasons of economy, comfort and ventilation; and in this case also alternative methods have not been adopted to any great extent. In houses larger than these a little luxury in the way of heating can generally be afforded, and one or other of the various smokeless devices will be found in use in some part of the house, but it is seldom that the coal fire is entirely absent. Our problem, then, is to provide a heating device which may replace the coal fire in all these different types of homes, remembering that in most cases any addition to the weekly budget would be a fatal drawback.

As the question of cost is of such vital importance, it will be of value to examine the various methods of domestic heating from this point of view. The accompanying table has been prepared, in the case of fuels, from the actual costs as delivered in South-east London; the figure for electricity is hypothetical. In other localities, where costs are different, the figures will require amendment accordingly. The usual calorific values have been assumed.

It is not intended here to enter into the question of the efficiencies of apparatus in which the foregoing sources of heat are employed, as these vary so greatly according to the conditions of use. It is cheaper, for example, to use an electric radiator or gas fire in a room which will be occupied for a short time only rather than to light a coal fire. The conclusion to be drawn from the

Source of Heat.	Cost.	British Thermal Units for 1 penny.
Gas Coke	37s. per ton	60,000
Household Coal ..	48s. ,, ,,	57,000
Low Temperature Carbonisation Coke	52s. ,, ,,	45,000
Anthracite Coal ..	69s. ,, ,,	40,000
Coal Gas	8¾d. per therm	11,400
Oil for oil stoves ..	1s. 2d. per gallon	11,400
Electricity ..	1d. per unit (kilowatt hour)	3,415

figures is that for continuous burning solid fuels are much cheaper than other materials or methods, and that the solution of the smoke problem must be sought on lines involving the use of a smokeless, solid fuel. The possibilities of each kind will now be considered.

Attempts to use coke for open fireplaces date back for more than three centuries. In 1626 Sir John Hacket and Octavius de Strada obtained a patent for converting coal into coke, " in order to make it as pleasant a fuel for chambers as wood or charcoal." The project was soon abandoned, and it was not until after the commencement of the manufacture of coal gas, in which coke appeared as a by-product, that any serious trials were made with a view to using gas coke in open fires. It was found to be difficult to ignite and only to give a dull fire in the open grates generally in use in the last century, and it was commonly believed that gas coke was unsuitable for open fires. Hence arose the idea of low-temperature carbonisation, by means of which a material with properties half-way between coal and coke could be procured which would burn without smoke in existing fireplaces. It is only during the last ten years that scientific work has been carried out with a view to modifying the fireplace so that gas coke could be burnt satisfactorily. In this connection Prof. C. Vernon Boys was the first to call attention to the effect of thermal conductivity on the combustion of fuels in an open fireplace. If an isolated piece of coke be lighted at one corner it does not continue to burn, because the loss of heat by radiation and conduction through the coal lowers the temperature below the point of ignition. In lighting a coal fire it is necessary to ignite a large area of surface in order that the coal may maintain itself above the point of ignition by the heat given out, and only then will combustion proceed. The temperature attained will depend upon the rate of burning, which in turn will be influenced by surrounding conditions ; a piece of coal, for example, which is in contact with the iron cheeks of a fireplace will only burn on its inner side owing largely to the cooling effect of the iron. Gas coke, which is ordinarily more difficult to burn than coal, is greatly affected by contact with masses of metal in the fireplace and with the small draught existing only burns brightly

in the centre of the fire. Boys showed, however, that in a fireplace lined throughout with firebrick coke would attain a much higher temperature than when masses of metal were in contact with it. Further modifications were needed, however, before the coke fire could really be pronounced satisfactory; and in a paper read before this Society on March 9th, 1927, by Dr. E. W. Smith, several types of open grates for burning gas coke are referred to. Some weeks

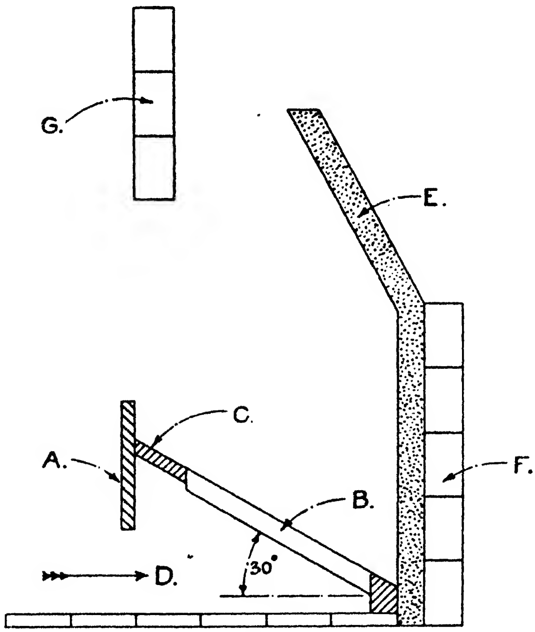


FIG. 1.

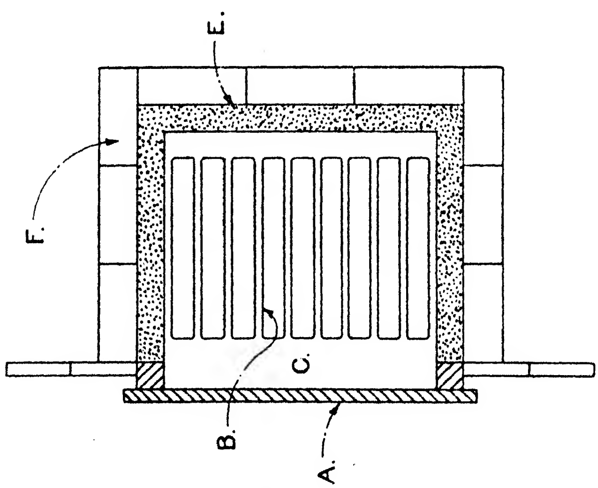


FIG. 2.

before Dr. Smith's paper was read the present writer had been trying an open coke fireplace installed by the South Metropolitan Gas Company, and his early experiences were described in the discussion which followed the reading of the paper (*Journal* R.S.A., May 6th, 1927). This trial has now extended over a period of two years, and a description of the fireplace and an account of its performance should be of interest.

The construction of this fireplace is shown in Figs. 1 and 2, the former being a sectional elevation and the latter a plan. The novel feature is the slope of the firebars, *B*, which are inclined at an angle of approximately 30° to the horizontal from front to back. As seen in the plan, the firebars are widely spaced so as to permit of an adequate air supply for combustion. At the upper

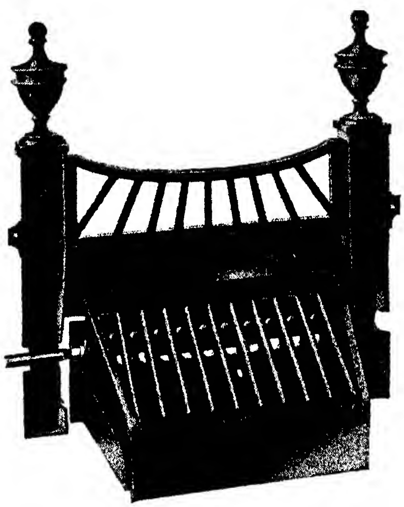


FIG. 3.

end the firebars are connected to a dead-plate *C*, which forms a part of the front of the grate. The sides and back of the fireplace are lined with firebrick *E*, which is backed by insulating bricks *F*. A gas burner (not shown in the drawings) is located at *D* and is provided with jets opposite to the spaces between the firebars, protected from falling dust by the dead-plate *C*. Fig. 3 is a reverse view of the grate and shows clearly the arrangement of the firebars and jets. To start the fire ordinary broken coke of size from 2 inches to ¾ inch is put into the fireplace and the gas jets ignited. After about 15 minutes the jets are extinguished and the fire is then established. The combustion increases in vigour until the coke attains a bright white heat and is accompanied by flames which add to the pleasing appearance of the fire.

No attempt has been made by the present writer to test this fire with scientific appliances on the lines adopted by Dr. Margaret Fishenden in her researches on domestic fuels, as such tests require special apparatus and continuous

observation. Actual figures as to the quantity of heat radiated into the room cannot therefore be given, but as the fire is somewhat hotter than one in which semi-coke is burnt in an ordinary grate of good design, it is safe to assume that more than 30 per cent. of the heat of the coke is thus given to the room. The highest figure obtained by Dr. Fishenden for cakes of semi-coke was 30.8 per cent. (Fuel Research Board, Technical Paper No. 3), and for coal 24.2 per cent.; so that in the gas coke fire under notice 35 per cent. would probably not be an over-estimate. In the present case, however, it was thought better to test the fire under ordinary household conditions of use and to compare the costs with those of a corresponding coal fire. As the result of two years' use in all types of weather, it has been found that the temperature of the room can be maintained by a consumption of gas coke not exceeding in weight the coal

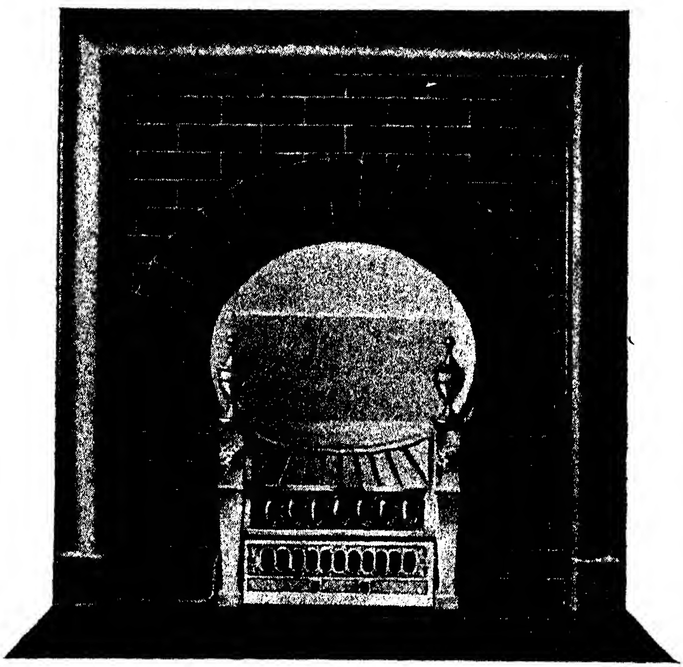


Fig 4.

required in an equivalent fire. The financial saving in fuel is therefore represented by the difference in price between coke and coal, which varies with the locality and according to the figures given earlier in the paper amounts to about 25 per cent. In addition to less fuel costs, however, the fire has many other advantages. It dispenses with the use of sticks and paper, and owing to the dead-plate *C*, no ashes can drop out in front of the fire, but are all collected in an ashpan below and are easy to remove. The temperature can be regulated by passing a poker between the firebars, although the downward

slope of the bars renders the fire partially self-cleaning, as when the fuel contracts on burning the coke in front slides down and adhering ash is loosened and falls through the spaces. The temperature is never so great as to form clinker or to cause fusion of the firebrick. The easy and largely automatic removal of ash, combined with good thermal insulation, are the special features which enable gas coke to be burnt so as to produce a fire superior in every respect to the ordinary coal fire and at a smaller cost. The actual appearance of the grate in shown in Fig. 4.

Let us now consider whether a fire of this kind can be applied to the smallest homes so as to replace the coal fires generally in use. As a kitchen fire in a five or six-roomed house this arrangement, which will enable cooking operations, heating of flat-irons, etc., to be carried out, is quite simple and more efficient than in the case of the coal fire, in addition to being cleaner and cheaper in use. The cost of the gas used in ignition is counterbalanced by the saving in fire-

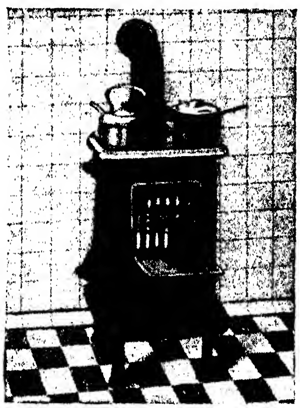


Fig. 5.

wood and the fees of the chimney sweep. In new houses the coke fireplace could be installed at a cost little greater than that of the ordinary grates; in existing houses the cost of replacement is not great, and would be recovered by the saving in fuel. Similarly, in seven or eight-roomed houses the sitting-room fireplace could be made initially to burn coke or existing grates easily modified to this end. In larger houses in which the occupants could without difficulty afford the outlay, it would be an advantage to replace all existing coal fires by arrangements for burning gas coke, giving a cleaner home and yet losing none of the advantages of the coal fire.

To avoid misunderstanding the writer wishes it to be known that he has no financial interest in the fireplace described, and would add that any other contrivance for burning gas coke which fulfilled the same requirements would be of equal value if equally cheap and simple. For kitchen use in small homes hot-water boilers are now made which can be converted into open fires when desired, and on the hot top of which a certain amount of cooking can be con-

ducted; and if designed to burn gas coke and to work economically will be preferred by many to the open coke fireplace. An example is illustrated in Fig. 5, which represents an open-fire kitchen boiler made by the Beeston Boiler Company. Both this and the fire previously described are capable of burning domestic refuse.

Assuming, then, that in all fires coal could be replaced by gas coke, the domestic smoke nuisance would appear to admit of an easy solution, accompanied by the further advantage of reducing the fuel bills of the consumer. Unfortunately, the amount of gas coke available for domestic use is quite inadequate to supply what would then be needed for household purposes. The total production of gas coke throughout the country is roughly 12,000,000 tons, of which more than 3,000,000 tons are used for heating retorts, etc., in the works. About 2,000,000 tons of the remainder are either converted into water gas or exported; but, even if the latter quantity were used instead for domestic purposes, the total supply would only be 9,000,000 tons, as compared with a coal consumption of 36,000,000 tons. In London the corresponding figures would be about 3,000,000 tons of coke and 8,000,000 of coal. Evidently, therefore, further supplies of suitable fuel from some other source are essential if the domestic smoke problem is to be solved completely. An obvious method of obtaining larger quantities is to carbonise more coal, but this can only be done on an economic basis. In recent years much research on the carbonisation of coal at low temperatures has been carried out, and many projects have been launched with a view to placing the process on a commercial basis. The aim in many cases has been to obtain a high yield of oils and other valuable by-products and to procure a solid residue of light coke, which would burn in an ordinary domestic fireplace. The question of the future success or otherwise of low temperature carbonisation does not arise here except so far as the solid residue is concerned. This, in order to compete with gas coke, must be sold at as low a price. The fact that gas coke can now be used in the open fireplace completely alters the outlook, and there is now no need for a semi-coke, less durable and occupying more cellar space than gas coke, in the domestic circle. A treatment of coal which gave the necessary yield of oils, etc., and left a residue of the nature of gas coke, if economically sound with regard to the disposal of the by-products and gas produced, would effectively solve the problem of the shortage of smokeless solid fuel. It is earnestly to be hoped that the intensive research which is being conducted will result in the perfection of a process of this kind, as, in addition to providing smokeless solid fuel, it should lead to a greater consumption of gas and aid in this way also to prevent the production of smoke.

Apart from coke, the only other solid smokeless fuel obtainable in large quantities is anthracite coal. This fuel may be burnt with moderate success in an ordinary open fireplace, but is difficult to ignite. Burnt in the gas coke grate, using a gas-flame igniter, anthracite is an ideal fuel with only one drawback—its

high cost. The best size to employ is that known in the trade as "French nuts," which are about 2 inches in maximum and 1 inch in minimum dimension. The anthracite ignites rather more readily than gas coke and gives a more enduring fire, the appearance of which leaves nothing to be desired. Comparative tests over a short period indicate that about 3 pounds of anthracite are equal to 4 pounds of coke, and if prices were in the same ratio anthracite would be preferable on account of its smaller content of ash. To compete with coke at 37s. per ton the price of anthracite should not exceed 50s. per ton, but in London the cost is about 20s. per ton above the competitive figure. Whether on the basis of larger sales and increased economy in production the cost of anthracite to the consumer can be reduced sufficiently to compete with gas coke is a matter which the interests concerned might do well to consider. Cheap anthracite would complete the solution of the smoke problem; and in homes in which a little luxury in the matter of fires is permissible an anthracite fire in a suitable grate will be found to be cleaner and of better appearance than an ordinary coal fire. Now that gas coke and anthracite can be burnt to such advantage in an open fireplace without sacrificing any of the amenities of the ordinary coal fire, there is no reason why smoke should any longer be produced in large houses, clubs, or hotels. But we must always keep in mind that the domestic smoke problem is one which mainly concerns the small homes, in which cost is a vital factor.

So far we have only considered solid fuels burning in an open fireplace, and the question of alternative methods now arises. Had it not been for the extensive use of gas fires and cooking stoves, electric radiators, ovens and other contrivances; hot-water boilers and radiators; closed anthracite stoves, and, to some extent, oil stoves, the smoke nuisance would have been much worse than it is at present. Those who can afford to use these appliances without troubling about cost will be well advised to do so; but their application in small homes is limited by the question of finance. When the national scheme for the distribution of cheap electricity comes into operation, we may reasonably expect to procure current at one penny per unit for heating purposes, and at this price even the smallest homes might with advantage have a few electric appliances. Although the solid fuel fire is the cheapest for continuous use, its advantages disappear when the heat is required only for a short time; and the complete equipment of any house should include arrangements for occasional as distinct from continuous heating. Taking the case of a five or six-roomed house, a gas cooking stove should be installed as the cheapest means of preparing food in cases when the kitchen fire is out of use—e.g., early in the morning and in hot weather—or when it does not possess an oven. Heating arrangements should be provided for the bedrooms, one of which should be a grate for solid fuel, to allow for prolonged occupation in case of sickness; other bedrooms should be fitted with gas fires or wired for an electric radiator. Oil stoves may also be used for occasional heating if the room is well ventilated, the colourless

flame type being preferable. Hot water should be procurable by means of a chimney boiler in the kitchen fireplace, or, alternatively, the combined boiler and fire as shown in Fig. 5, may be used. In the seven or eight-roomed house the same scheme should still apply, an electric radiator being used in the sitting room when the fire is not lighted and a little heating is desirable. In this manner, and without any increase in weekly costs, all these houses can be made smokeless. Houses larger than these, in which a little luxury in heating can be afforded, may be fitted with hot-water boilers and radiators, gas or electric cookers, gas fires or electric radiators, or any of the many contrivances now on the market, according to the means and preferences of the occupiers.

In conclusion, we may consider the definite plan of action to be followed to abolish domestic smoke, having regard to existing and future conditions. Firstly, remove the ordinary coal fire from the designs of all new houses, of whatever size, putting in its place a smokeless fireplace, thus securing that no further additions to the smoke shall be made. This is a matter which specially concerns local building authorities and medical officers of health, who should use their full powers to secure this change. Secondly, efforts should be made to induce landlords and tenants of existing houses to convert the grates at present used for burning coal into the smokeless variety. Although this would entail a small outlay, the cost would be recovered later by the saving in fuel effected, and an arrangement might be made between landlord and tenant so that neither would suffer financially. Here again local authorites and medical officers of health can do much to bring about this desirable change. The rate of progress will depend upon the efforts made, but a persistent campaign is bound to lead to a notable reduction of smoke in a short time. By the time the consumption of gas coke has caught up to the present supply we may reasonably expect suitable fuel from other sources, such as modified processes of low temperature carbonisation which give an end-product of coke of the same nature as gas coke. Incidentally, the production of this extra supply of coke would greatly increase the quantity of coal gas available and by reducing its cost greatly extend its use for household and power purposes. Alternatively, a large use of anthracite might make it possible to reduce its present price by a sufficient margin to bring it into competition with gas coke. If the plan suggested were followed, before many years were over domestic smoke should become a dark dream of the past. The only sufferer would be the chimney sweep, whose occupation would be gone.

DISCUSSION.

The Chairman, in opening the discussion, said the lecturer had put forward very practical and definite suggestions for combatting the smoke nuisance. A certain amount of progress had already been made, mainly through the agency of gas; but the enormous quantity of raw coal still used for domestic purposes in this country was evidence of how much still remained to be done. Including

miners' coal, this amounted to 40,000,000 tons annually and represented nearly one-fourth of the total consumption for all purposes. Not only was it a very high figure, but since domestic coal was burned in a far more inefficient manner than industrial coal, it threw out smoke out of all proportion to its bulk. Further, the smoke was of a tarry, sticky nature, and was in consequence more harmful than industrial smoke. Much of the prejudice against gas coke was without foundation. There were of course certain uses of gas coke which were considered to be more or less legitimate. It was for instance, well known to be a suitable fuel for independent boilers or for the small boilers of central heating installations, and there was also evidence to show that coke compared favourably with coal for big scale boiler work ; but what she was now referring to was the use of coke for ordinary domestic purposes. Gas coke of reasonably good quality would burn satisfactorily in many open grates. Certain conditions had of course to be fulfilled. For instance, the grate should be well insulated ; it should have a fairly deep bed of fuel, and there should be good draught control, since there might be a tendency for coke, which was a non-caking fuel, to burn too fast when combustion got well established. There remained the difficulties of ash disposal, and of ignition ; but if a grate embodied all the features mentioned, and if a gas fire-lighter with ample consumption were available, she was inclined to agree with the lecturer that ignitibility might not be the essential feature to be sought. In such circumstances the criteria of a really good domestic coke would probably rather be low ash and moisture content, for under such conditions it was possible to light and burn not only gas coke but harder cokes still.

The lecturer would be interested to know that at the Fuel Research Station there was now in progress a systematic investigation both of cokes, and of grates for burning cokes. They had been working in the first instance mainly from the point of view of how easily a coke could be lighted—not because they thought that was the only thing that mattered, but because they believed it was one very important thing, since, after all, practically the whole of the 40,000,000 tons of domestic coal was burned in grates that had not gas fire-lighters installed. It might be interesting to remark that low temperature cokes could be brought, after consumption of only 2 or 3 cubic feet of gas, to a stage when they would support independent combustion. Even for gas cokes 4 or 5 cubic feet of gas was sufficient. They had been able to light hard metallurgical coke by giving it enough gas and had obtained extremely good fires from it. If a gas fire lighter were available it would not matter much whether one burned 5 or 10 cubic feet. There were still, however, a great number of cases where ease of ignition was of considerable importance. From that point of view undoubtedly low temperature cokes scored. They could be lighted by the methods to which the ordinary housewife was accustomed, were more rapidly controlled than gas coke, and could be used in existing types of grates. One thing, however, should be remembered, namely, that low temperature cokes were subject to variation, just like ordinary gas coke, according to the coal from which they were made. They might be disagreeable fuels if they contained too much ash. She was not of the opinion that the exact efficiency attained was of very much consequence beyond a point. It was known that on the whole coke was rather more efficient than coal, and she did not think an extra 1 or 2 per cent. efficiency would count very much against convenience. A very large quantity of coke would be wanted if any real mark was to be made on domestic smoke, and a point of real importance was the disposal of the other products, unless we were going to embark on schemes of complete gasification. Whatever type of coke were adopted it would be necessary very considerably to enlarge the present works, and from that point of view the fact that gas coke was already available was not a strong argument, because new plant would, in any case,

have to be put up if the demand increased very much. Such plant could be designed for making either low or high temperature coke as desired, but it was possible that in either case the gas industry, which was accustomed to deal with sales of carbonisation products, would be the most suitable to exploit it. If gas coke were used it would be necessary also to dispose of the gas and it had even been suggested that a time might come when gas would be used to heat the retorts, owing to the increased demand for coke.

She was not quite so optimistic as the lecturer in thinking that the problem was entirely solved when a coke was found which would burn in sitting room grates, or even in kitchen ranges. It was necessary to point out that it was not enough for a coke to burn; it must also do its job, and although coke was quite satisfactory in kitchen ranges for hot water production, it sometimes failed to heat the oven. The gas cooker was an efficient appliance, and in some circumstances it paid to use gas for cooking. There were also many houses which needed to keep the kitchen fire going for general purposes and where it would be an extravagance to have a gas cooker in use as well. That was a real point, and one to which grate manufacturers should turn their attention.

The requirements of different types of households were very dissimilar, and the installation or equipment best suited for one house was quite different from that best suited for another. There was, therefore, room for a big expansion in the use of both gas and coke of various kinds. It was a pity anthracite was so dear but it had its uses and the solution of the smoke problem would most likely be found in a combination of the use of many different types of fuel.

She would like to ask the lecturer whether, in the grate which he had demonstrated and which did not appear to have any damper for closing the ingress of air below the fire, there was any difficulty from its over-rapid burning.

Mr. Ll. B. Atkinson (Past-President of the Institution of Electrical Engineers) said that for 40 years he had attended on every possible occasion any lecture which aimed at getting rid of the smoke nuisance of our great cities. He recalled the fact that it was in that very room about 40 years ago that Sir William Siemens had exhibited a coke fire with a gas igniter; why that appliance had died out he could not say. The lecturer had stated very fairly the case for the various fuels, but it seemed to him that, in discussing all the niceties of the comparative costs, the most important thing of all had been forgotten, namely, the enormous bill of ill-health which all had to pay by living in cities over which hung a perpetual pall of smoke, soot and dirt. Only within the last few years had people learned how largely their health depended on having ultra-violet light or short-wave radiation on them from above, but those things could not be obtained in cities like London with its pall of smoke. The fact was that people now had to put up with the smoke and to purchase some apparatus for the purpose of enjoying ultra-violet ray baths. If only people could get a full dose of sunshine through their city air, half their troubles would disappear. The smoke nuisance would never be cured until this country adopted the drastic cure which had been adopted by other countries, where there were alternative fuels,—namely, legislation which did not allow smoke. It would not, however, be fair to put such legislation into immediate effect in this country, because alternative fuels did not exist at the moment. We had to try, therefore, to discover those alternative fuels and to bring them into existence; and that was what the Research Board was trying to do. New York, for instance, did not allow smoke to be made. He remembered once walking down one of the main streets of New York and seeing some smoke. Knowing that no smoke was

allowed there he immediately thought that a fire was raging, and he went to a police officer to inform him. The officer, however, had said to him, "Do not be alarmed, or ring the fire alarm, as that is a baker's oven, and bakers are allowed to make smoke." He merely mentioned that in order to show that smoke was such a rare thing in New York that when a person saw it he immediately wanted to ring up the fire brigade under the impression that it was a fire. He was indebted to the lecturer for showing one way in which the disgraceful and dirty habit of burning raw fuel could be dispensed with.

MR. A. H. BARKER (Past-President of the Institution of Heating and Ventilating Engineers) remarked that when a man prevented smoke he did not prevent it for the benefit of himself so much as for the benefit of his neighbours; and when one invited a man to spend a considerable sum of money in order to get rid of smoke, one was inviting him to present something free of charge to his neighbours or to society at large. Human nature being what it was, the prospects of success in a matter of that kind were rather small. The only possible way in which the necessary reforms could be achieved was by legislation. So soon as a fuel could be provided which would enable people to obey such legislation, the time would have arrived at which to press for suppression of smoke. There was only one perfect way of reducing smoke under present conditions, and that was by increasing the use of gas. There was no reason, of which he knew, why a gas fire should not be made which was in most respects at least the equivalent of a coal fire. The main feature of such legislation would be the prohibition of the use of ordinary smoky coal. Unfortunately, however, it was the use of smoky coal which made the attractiveness of the coal fire. He could not blind himself to the fact that the appearance of a coal fire, with its flickering flame, and its smoke blowing away in weird and fantastic shapes, had a fascination which no coke or gas fire could ever have; and if one was going to try to deprive people of the exquisite pleasure of sitting in front of a fire of that sort, one would have to have very strong powers in order to be able to do so.

With regard to the question of costs, it was an exceedingly difficult one, because the range of cost as between different fuels varied both according to the way in which the fuel was used and according to the apparatus in which it was used. There were only two ways in which the relative costs of different kinds of fuels could be measured—the laboratory method and the practical method; and the number of different practical methods varied with the number of different ways in which fuel could be used. The difficulty was that the way in which fuels were used in practical life was not the same as the way in which they were burned in the laboratory. The problem of relative cost was an excessively complicated one

SIR ALFRED COPE, K.C.B. remarked that he was engaged in the anthracite industry. Very little had been said that night with regard to anthracite. Reference had been made to the glories of New York. New York was not heated by gas coke, nor by low temperature coke, nor by gas or electricity; it was heated by anthracite. His company—the largest producers of anthracite—were exporting to-day to America upwards of half a million tons a year. They were exporting the same amount to Canada. One need not go as far as to New York in order to see the benefits of a smokeless city; one had only to go to Paris, to which this country was exporting one million tons of Welsh anthracite per annum.

He regretted that so much should have been heard of the fact that we had to look forward to to-morrow. Thousands of pounds were being spent in finding out the advantages of gas coke, the kind of apparatus in which it could be burned, how

it could be ignited, and so on, and yet there was at our very doors a natural smokeless fuel in anthracite. Everyone was an advocate of smoke abatement. Nevertheless, the fact seemed to be overlooked that upwards of 80 per cent of this country's production of natural smokeless fuel was exported to countries abroad.

The lecturer had stated that one of the difficulties in obtaining smoke abatement in this country was the inadequate production of gas coke. The lecturer had stated that 7 million tons was the maximum production, and that he looked round for some addition. The anthracite produced in this country was equal in weight to the 7 million tons which the lecturer had referred to, and the thermal efficiency of anthracite as compared with coke, was not in the proportion of 4 to 3, but somewhere in the nieghbourhood of 3 to 2, so that 7 million tons was equal to about 10½ million tons of gas coke. Adding that 10½ millions equivalent of gas coke to the existing supply of gas coke it meant that there was something approaching 20 million tons available. If those interested, by their united efforts, could get 20 million tons of smokeless fuel used in this country, they would be going a long way towards achieving the object in view.

A great deal had been said of the advantages of gas coke for water heating. Certainly it was a very good water heater, but it had many drawbacks, one of which was that the storage capacity of coke was out of all proportion to its heating value. Anthracite took up about half the space of coke, and it did not absorb moisture. Whereas coke contained from 10 to 20 per cent of ash, anthracite did not contain more than 5 per cent.

THE CHAIRMAN said Sir Alfred Cope had stated a good deal about the excellence of anthracite, which nobody denied, but what one would like to know was something about the price. Were its advantages sufficient to outweigh its very much higher cost ?

SIR ALFRED COPE replied that anthracite could certainly never be 50s. per ton, which the lecturer had stated was the price at which it would become competitive with coke ; but if smoke was to be done away with it was not only a question of the first price, but a question of the savings of the housewife in laundry bills, for instance. There was also the question of health and hygiene.

MR. G. NELSON HADEN said it had perhaps been forgotten by previous speakers that in the case of New York a good deal of heating was done from district heating stations. There were in the United States some 400 towns heated to a very large extent from district heating stations. In Detroit there were three main stations, and at one time there were only about five of the large-sized buildings which did not take steam for heating purposes from the central stations. If one went to the outskirts of Detroit and looked over the town, one would see practically no smoke at all from the central station stacks.

MR. W. W. NOBBS (Past-President of the Institution of Heating and Ventilating Engineers) mentioned one point of interest to him as an electrician. As to the use of coke, he only had experience of it in large installations. A short time ago he had attended a lecture at which an electrician had expressed the view that the electric generating companies could sell electricity, at a profit, at .36d. per unit. That gentleman had shown that by maintaining the stations at their maximum capacity, and by turning the excess current generated through a different system to be utilised for heat—heat storage, central heating or hot water heating—the costs would be so lowered that they could sell the surplus heat, at a profit, at .36d.

From what had been said that evening it might be suggested that they might go still further. Why, in such a case, should it not be possible for them to carbonise the smoky fuel, use the gas to heat their boilers, and thus give electricity as a by-product—selling the coke for such purposes as had been mentioned that evening. He thought that was not a too far-fetched solution of the smoke abatement problem, and perhaps more would be heard of it in the future. It seemed to be just as practicable a solution as the use of coke in open grates.

MAJOR P. H. RICHARDSON thought it would be fair to anthracite to point out the difference in the ash and water content of anthracite and coke. He had always held the view that those interested in coke would not secure a very greatly increased use of coke until they took care to reduce the ash content and also the water content —or, rather, the water which coke absorbed. There was 4 or 5 per cent. of ash inherent in anthracite as compared with 15 to 20 per cent. of ash inherent in coke. With regard to the water content, anthracite had about 4 per cent. of water and would not absorb more. Coke had 7 or 8 per cent. of water and would and could absorb up to 20 per cent. When it was realised that both water and that ash had to be heated up to the temperature of the fire and then the ash had to be removed, it would be found that the B.Th.U. which one got from coke for a penny and the B.Th.U. that one got from the anthracite were nearly equal, without taking into account the cost of labour for removing the ash. He did feel that if the 7 million tons of potential output of anthracite could be used, added to the output of the coke which there was in the country, plus the output of coke from the coke oven people, we need not look very far ahead for the day when it could be said to Parliament that there was an alternative fuel ready and that a law should be passed that in three years' time smoke must not be put out into the air. He would stress the point that if Medical Officers of Health were more strict in using the influence which they had, the stage at which everyone wanted to arrive would be reached much quicker than many people thought.

MR. E. J. B. CLARKE said, as a stove man, that the very fact that a fire had to be lit by gas revealed the weakness of the case for coke. He pointed out that there were about 1,200 deaths last year through gas, and he thought the method which the lecturer had put forward that night was only increasing those risks. He agreed with the Chairman that low temperature carbonisation would provide one of the fuels of the future.

MR. ARNOLD MARSH (Secretary of the Smoke Abatement League of Great Britain) said he was sorry no distinction had been made in the types of coke with which the lecturer had been dealing. There was coke and coke. The older types of coke contained anything up to 20 per cent. of moisture and were unsuitable for the open grate, but the modern vertical cokes would burn excellently in an ordinary open grate. In Manchester they had had special opportunities of studying the smoke question. Taking Manchester alone, out of a population of three-quarters of a million, there were a half a million people living in houses generally known as "two up and two down." That meant that in those houses it would take years to fit in new types of grates. The problem had to be solved by giving such people a fuel which would be cheaper than coal and which would burn in the existing type of grate. The modern vertical coke would do that, and when low temperature fuel was got down to a reasonable price, as he thought it would be in the near future, then a fuel would be able to be given to those people in those small houses

in large congested areas, without the necessity of undertaking the almost impossible job of changing their grates and fittings.

PROFESSOR DARLING, in reply, said he had been sorry to observe that in the discussion the question of the capacity of the poorer people to pay for the necessary contrivances had not been taken into account. That lay at the root of the whole problem. One of the main reasons why he had advocated the burning of coke was because it was cheaper than anything else, at the same time being smokeless. Low temperature carbonisation coke had been coming as long as he could remember, but it had not yet come, and he did not think we could afford to wait until that millennium before getting a move on. There were three million tons of coke available in London for domestic use, and his suggestion was that we should get on using that, and then the movement would grow by its own force. It was all very well to say what was done in New York, but the average income of an inhabitant of New York was very much higher than in London. Most people here could not afford anthracite. He was a strong advocate of anthracite if it could be brought within the means of the classes who were now producing most of the smoke. If only the varied interests, who only seemed concerned to push their own gadgets as against all others, would come together and combine and have a common interest—namely, the removal of the smoke nuisance—then the problem would soon be solved, but so long as they were all at loggerheads, all advertising against each other, and pointing out the weaknesses of each other's methods instead of drawing attention to each other's good points, there must be a deadlock. Coke fires were growing simply by their own recommendation, but that was too slow a process. Legislation could not be enforced until an alternative fuel was available at a cost which the people could afford, but given those conditions he quite agreed that there should be legislation. In the meantime an immense amount could be done without legislation by all the interests combining and pulling together. By such means he thought the problem would largely solve itself.

LIEUT.-COLONEL SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., then proposed a hearty vote of thanks to the lecturer for his brilliant lecture. Personally, he regretted that not more ladies had been present that evening, because, after all, the question of what type of fire was to be established in a house, lay less in a mere man's hands than in those of his wife. He had been brought up in Rochdale—the dirtiest town in Lancashire. Any discussion of the sort which had taken place that night was of very real value. From his office in Finsbury Circus he could see something like 800 chimneys, not more than 80 of which he was certain were in any way necessary. If the number of chimneys could be generally reduced on that scale, there was no doubt that a great deal of good to the health of the community would result. Nevertheless, it was to be remembered that the health of London was on the average better than the health of the average rural district, so that Londoners had much to be thankful for.

He desired to invite those present to become members of the Society. They wanted good lectures, and the Society could give them. This session already an almost unique lecture on fuel had been given by a former Director-General of Naval Construction, which had been followed by a most valuable discussion. There were about to be given a series of three lectures by the Director of the Fuel Research Station at Greenwich—which was to fuel research all over the world what the longitude of Greenwich was to navigation all over the world. Lectures of equal value, which could not be surpassed in any other Institution in London, were given

at the Royal Society of Arts on most Mondays and on every Wednesday and often on Fridays, covering an extraordinary variety of subjects. The Royal Society of Arts was, he believed, the only learned Society which published a weekly journal, so that its members got week by week a complete paper, which they would refer to for years to come. The Society was not a fellowship of learning alone; it was a fellowship to encourage the arts, manufactures and commerce. Membership did not suggest that the fellows themselves were learned, but it meant that they were trying to learn, and to encourage others to learn. He extended a hearty invitation to all those present, and to others, to become members of the Royal Society of Arts.

The vote of thanks having been carried unanimously, the meeting terminated.

Mr. E. W. L. Nicol (London Coke Committee) writes:—As time did not permit of an adequate reply to those speakers who, admitting their personal interest in anthracite coal, represented gas coke to be a relatively inferior fuel, I now beg to offer the following contribution to the discussion on Professor Darling's interesting lecture on domestic coal smoke prevention. It was suggested by Sir Alfred Cope and Major Richardson that the moisture and ash content of gas coke was as high as 15 per cent. and 25 per cent. respectively. It would be as inaccurate and as futile to say the same of the finest solid fuel the world can offer, namely, Welsh and Scottish anthracitic coal. Coke is sold in competition with anthracitic and other high-priced coals, largely for domestic purposes, and finds favour entirely upon its merits as the more efficient and economical fuel. As Professor Barker pointed out, there is no generally applicable method of comparing the relative efficiency of fuels for all purposes, but the one unassailable method of comparison for commercial as well as domestic purposes is the net evaporative test adopted universally by mechanical and civil engineers. Such tests, which take into account the efficiency of both apparatus and fuel, are made continuously by important public authorities who are large consumers of gas coke for steam raising and central heating. These include the London County Council and the Metropolitan Asylums Board, whose published test results of coke-fired boilers prove an average overall thermal efficiency of 80-86 per cent., and a net evaporation of 10 lb. of water per 1 lb. of coke, while the Metropolitan Water Board, whose fuel testing laboratory is probably the best equipped establishment of its kind, purchase gas coke upon a guaranteed calorific value basis of 12,000 B.Th.U. per 1 lb., which necessitates the maintenance of a minimum ash and moisture content. There is therefore no possibility of selling to such large and discriminating buyers, or to any one of ordinary intelligence, coke of the description which exists only in the imagination of the speakers whose hyperbolic advocacy of anthracite coal at the expense of a successful competitor is indicative of the futility of intensive, but non-technical, fuel salesmanship—a common failing which, in my opinion, is largely responsible for the unfortunate position of the British Coal Industry at the present time. A calorific power of 15,200 B.Th.U. per lb. is often claimed for anthracite coal containing 2-3 per cent. ash; but this claim is difficult to reconcile with the fact that pure amorphous carbon (ash and moisture free) has a calorific power of only 14,560 B.Th.U. per lb. Perhaps our anthracitic friends will explain this apparent discrepancy, and its effect upon the apparent B.Th.U. per 1d. of cost, according to Professor Darling's tabulated figures.

As Engineer and Fuel Expert to the London Coke Committee it has been my privilege during the past 15 years to conduct personally many evaporative tests at electric and other power stations, in order to prove the relative efficiency and adaptability of gas coke to existing boilers and apparatus, with the selfish object of substituting coke for coal; and, on a cost and efficiency basis, which, usually, are the only criteria, there has seldom been any serious difficulty in competing successfully with raw coal of the most expensive descriptions. Similarly, coke has been adapted, by means of careful grading, for use in domestic stoves designed primarily for anthracite; and graded coke is now generally regarded as interchangeable with the latter fuel. But, of course, such competition is not in the true spirit of Professor Darling's lecture. His obviously unselfish object is to obtain for the benefit of the community the combined effect of anthracitic coal, electricity, gas and coke in combating the bituminous coal smoke evil.

With our vast supplies of indigenous smokeless coals (now largely exported) and manufactured smokeless fuels, gas and coke, and scientific stoking, much could be done by good salesmanship to break down the ignorant prejudice against smokeless methods of heating which, alas, is still all too common, even in high places. The important position of the gas industry in this regard is indicated by the service provided for the convenience of the Metropolitan community. At London and Suburban gas works in a normal year some 5.5 million tons of coal are carbonised, producing over 65,000 million cubic feet of gas and, in addition to the other valuable by-products 2,600,000 tons of gas coke for sale, of which about 400,000 tons are exported. The fact that the remaining 2,200,000 tons of coke are consumed annually in and around London, largely and increasingly for domestic purposes, should add materially to the dismay and confusion of coke's detractors, as it is irrefutable evidence that gas coke holds, on its merits, a very strong position in the favour of the London public. One speaker has pointed out that gas coke made in vertical retorts is more re-active and suitable for use as fuel in most modern fire-grates. The denser horizontal coke, like most solid fuels, gives the best results in grates specially designed for its use. These are divided into two essentially different classes, namely, the insulated (or built in) flaming type, in which the coke burns of its own volition at a relatively high temperature, the chimney draught having but little influence upon the rate of combustion. Of this type the "Metro" is undoubtedly the most effective and popular. The other type is represented by the positive or down-draught non-insulated (self set) grate which embodies means of control to which the Chairman and the Fuel Research Board have attached so much importance, and which certainly tends towards rationalisation, convenience, and economy in the use of fuel. Of the latter type, several models have been tested, but only those in which there is no metal in contact with the burning fuel, and which are provided with some form of shaking bottom, promise to survive the gruelling effects of coke in active combustion. After an expensive process of development and elimination, an open gas-ignited fire of this description will shortly be offered to the public at a relatively low price. Unlike gas and electric apparatus, which can use no other fuel, coke appliances are equally suitable for competing fuels; and it is in this direction, namely, in the co-operative design, development and sale of smokeless solid fuel apparatus that Professor Darling's high ideal of combination of forces in combating the common evil is, in my opinion, most likely to be realised.

OBITUARY.

CEDRIC CHIVERS, J.P.—We regret to announce that Alderman Cedric Chivers, who was in his sixth year of office as Mayor, died at Bath, on January 30th, at the age of 75. Mr. Chivers, who was a self-made man, established an international reputation as a book-binder. He invented a new method of stitching which added greatly to the life of library books as well as a new process for decorating choice volumes. He was well known in the U.S.A., where he had a factory in Brooklyn, New York, and in fact started operations there in response to a round robin addressed to him by American librarians. It was said of him that he had crossed the Atlantic 120 times, and that he had been in more libraries in the United States than anyone living.

Alderman Chivers established a reputation for dispensing a liberal hospitality to conferences meeting at or visiting Bath, and was a generous supporter of charitable causes. He had been a Fellow of the Society since 1901, and read a valuable paper on "Book-binding," at one of its meetings in 1925.

EXHIBITION OF APPLIED ART.

EXHIBITION OF POTTERY. Miss Down, 95, Belgrave Road, S.W.—It has probably often struck most people that vases which are beautiful in themselves do not necessarily make good receptacles for flowers. On the contrary, flowers spoil such vases. That it is possible to make vases deliberately to suit flowers, without sacrificing design, is proved by Miss Down's work. Symmetry she does sacrifice ; perhaps at present she is more dogmatic about the demerits of regularity than she will be later on, but anyhow, balance is just as valid a basis for design as symmetry, and the balance of Miss Down's vases is sometimes most attractive.

Miss Down is a pupil of Professor Ledward, and her personal bias is against the employment of the potter's wheel. She builds up her vases with pellets of clay—a little too often making her general effect suggestive of fir-cones—and afterwards bakes them : not in the sunshine on the banks of the Nile, as she logically should, with her views on mechanical aids to art, but in a small kiln.

Miss Down has produced both some fine monochrome glazes and some rather more matt painted surfaces. A really beautiful Chinese green is perhaps the best representative of the first group, and a pink gingham of the second.

Her present exhibition is humble only in its proportions ; we look forward to seeing more of her work soon, in a locality more accessible (for her sake, not ours) to the public which is interested in this pleasant aspect of ceramics.

NOTES ON BOOKS.

THE SPECTROSCOPY OF THE EXTREME ULTRA-VIOLET. By Theodore Lyman. London : Longmans, Green & Co. Pp. 160 + VI. 10*s*. 6*d*. nett.

We have been familiar for many years with the fact that X rays, ultra violet rays and ordinary light are radiations which owe their characteristic differences to their differences in wave-length. It has, however, required considerable time and experimental skill on the part of a large number of observers to produce and measure the whole range of radiations from the wireless waves at one end of the spectrum to the cosmic rays at the other.

Considering the radiations of wave-length less than those of visible light, we find that Ritter in 1801 discovered chemically-active rays beyond the violet, which

Young showed were of a shorter wave-length than those observed by the eye. About 1840 the solar spectrum was photographed using glass prisms and gratings, while wave-length 3,400 A.U. was reached. The next considerable advance was due to Stokes about 1862, by the use of a quartz prism, an electric spark and a fluorescent screen. He appears to have observed the strong line in the aluminium spark at wave-length 1850 A.U. This remained the limit until comparatively recent times. It will be noticed that each further penetration into the ultra-violet was accomplished as a result of the application of a change either in the dispersion system, in the light source or in the method of recording. Subsequent developments have since been accomplished by the same methods, each change resulting in a substantial advance into unexplored territory.

It was Schumann, however, who gave the impetus to modern investigations in this region. This remarkable worker commenced his scientific work when over forty years of age as a relaxation from his regular profession, and it is in honour of his brilliant pioneer work that his followers have named the portion of the spectrum below 2,000 A.U. the Schumann region. At the time of his death in 1903, after about fifteen years work, he had managed to observe the spectrum down to about wave-length 1,200 A.U. To do this he had to substitute fluorite for quartz, since quartz begins to absorb at about 1,850 A.U., prepare special plates without gelatine, since gelatine begins to absorb at about 2,400 A.U., and also to place his apparatus in a vacuum, since air begins to absorb near 1,850 A.U. With these modifications he obtained the spectrum of hydrogen down to about 1,200 A.U. Schumann, however, was not able to measure wave-lengths in this region, owing to the absence of data on the dispersion of fluorite.

It was at this stage that Lyman commenced his researches. He improved on Schumann's apparatus as a result of development in vacuum technique, and by substituting a concave grating for the fluorite prism and lenses was able to make the first measurements of wave-length in the Schumann region and so attach a wave-length scale to Schumann's results. By 1914, when the first edition of his well-known book was published, he had made measurements down to about 900 A.U., by 1915 to about 600 A.U., and by 1917 to about 500 A.U.

The next and final advance was made by Millikan in 1919 by the use of a new source—the vacuum hot spark, which is particularly rich in short wave-length radiation. The present limit of the optical spectrum as set by Millikan in 1924 is the line 136 A.U., which is thought to be due to oxygen, or possibly to be one of the L series of the X rays from aluminium. Thus by optical methods the region of X rays has been reached.

Contemporaneously with the work of Lyman and Millikan, observers working from the X ray end of the spectrum have been measuring softer and softer X rays, until in 1926, Dauvillier, using as a grating a crystal of the lead salt of mellissic acid, which has the extremely large lattice spacing of 87.5 A.U., measured X rays of wave-length 121 A.U. from thorium.

Finally the gap was bridged by Osgood in 1927, who used a concave glass grating with X rays at grazing incidence. He obtained on the same plate lines corresponding to wave-lengths from 45 A.U. to 211 A.U., thus joining and overlapping the limits set by Dauvillier and Millikan.

In the second edition of his book, which has just appeared, Professor Lyman gives an account of the experimental technique for which he has largely been responsible in connection with photography and measurement in the ultra-violet portion of the spectrum.

Professor Lyman also gives a summary of the researches which have been undertaken to explain the sharp limit in the solar spectrum which is observed near wave-

length 2,900 A.U. This has long been attributed to absorption in the earth's atmosphere, but as the limit is practically the same at sea level and at 12,000 feet, it was difficult to account for satisfactorily. Recent investigation indicates that the limit is due to the absorption of zone at an altitude of 45 to 50 kilometres.

The major portion of the book, however, consists of data on the absorption and reflection characteristics of a number of elements and compounds, and also wavelength data on emission spectra.

Professor Lyman has written a very useful book on a very interesting subject, and although the treatment is scarcely suitable for the general scientific reader, it should, however, prove of great value to the research worker in this most important region, both as a manual of method and as a reference book of data.

Very few misprints have been noted. The author appears to be mistaken in the origin of some of his gratings. They were made on the Blythswood ruling engine at the National Physical Laboratory. We are unacquainted with the Blaesthwood machine or the National Research Laboratories in England.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 18..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Mr. J. Alfred Gotch, "Modern Banks, with special reference to the new Midland Bank Head Office."

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

British Empire Producers' Organization, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m. Sir Benjamin Morgan, "Intra-Empire Economic Co-operation."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Modern High Power Rectifiers: their Development and Use." opened by Mr. R. L. Morrison.

At the University, Liverpool. 7.30 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Mr. Edward Corcoran, "Experiences as a Farm Hand in Canada."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. G. Binney, "Hudson Bay in 1928."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. George Bird, "Railway Brakes."

University of London, at University College, Gower Street, W.C. 2 p.m. Miss M. St. Clare Byrne, "Elizabethan England."

5 p.m. Dr. W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture III.)

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture II.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture VI.)

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Lt.-Col. T. C. Skinner, "The Ice Age: its Astronomical Cause and the Bearing of Drayson's Discovery on the Biblical Account of the Deluge."

TUESDAY, FEBRUARY 19..Automobile Engineers, Institution of, at the Engineering Scientific Club, Wolverhampton. 7.30 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. A. H. Barker, "The Electrical Heating and Ventilation of Bourne and Hollingworth's Premises, Oxford Street."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. W. Cruickshank, "Voice-Frequency Telegraphs."

Heating and Ventilating Engineers, Institution of, at Milton Hall, Manchester. 7 p.m. Mr. G. E. Shuttleworth, "Dust Removal."

Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, S.W. 6.45 p.m. Discussion on various Problems in Illuminating Engineering.

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. E. C. Evans, "Fuel."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture IV.)

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Dr. A. Bradford Hill, "The Investigation of Sickness in various Industrial Occupations."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. Frank Pick, "The Administration of Transport Undertakings."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. A. A. Jackson, "The Sphere of the Railless Trolley Vehicle."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question: (Lecture VI)—The Crimean War and the Treaty of Paris."

5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Traction." (Lecture II.)

At the Royal School of Mines, South Kensington, S.W. Mr. F. L. Engledow, "Plant Breeding." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. (Lecture IV) on "The Current Work of the Biometric and Eugenics Laboratories."

8.15 p.m. Miss E. Jeffries Davis, "Historical Factors of the Problem of London Traffic." (Lecture III.)

Zoological Society, Regent's Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, FEBRUARY 20..British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Mr. Stanley Casson, "Excavations in the Hippodrome at Constantinople (Second Season)."

Central Asian Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Dr. Anderson, "The Highway of Eurasia."

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Mr. H. I. Beel, "Egypt under the Caliphs of Damascus."

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Address by Lt.-Col. K. Edgcumbe.

Geological Society, Burlington House, W. 5.30 p.m. Dr. C. A. Matley and Mr. F. Higham, "The Basal

Complex of Jamaica with special reference to the Kingston District."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. Mr. L. H. G. Dines, "The Baker automatic release for dropping the meteorograph from a registering balloon at a predetermined height." (2) Mr. C. K. M. Douglas, "Some Aspects of Surfaces of Discontinuity." (3) Dr. E. Kidson and Mr. H. M. Treloar, "The Rate of Ascent of Pilot Balloons at Melbourne."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. (1) Dr. R. G. Canti and Mr. F. G. Spear, "Some Effects of Radium on Cell Division *in vitro*." (2) Mr. S. F. Cox, "Some Effects of X-Rays on Cell Division *in vitro*." (3) Mr. F. G. Spear, "An Effect of Low Temperature on Cell Division *in vitro*." Demonstrations by (1) Mr. S. F. Cox on "The Effect of a Heavy Dose of X-Rays on Living Cells as shown by the Dark-Ground Method." (2) Dr. R. G. Canti on the "Cell Division in the Living Tissues cultivated *in vitro*."

United Service Institution, Whitehall, S.W. 3 p.m. Group Captain P. F. M. Fellowes, "The Present Position of Airships."

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne. 7.15 p.m. Mr. W. G. Thompson, "Some Unusual Aspects of Combustion in Engines and Boilers."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture I.)

At King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History: (Lecture VI)—Mr. H. M. Hake, "English Portraits."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928: (Lecture VI)—Novels of the Revolution: Pilnyak to Fedin."

At the London School of Economics, Houghton Street, Aldwych, W.C. 6 p.m. Mr. F. Hutchinson, "Measuring Output in Office Practice, II."

At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture V.)

5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture VI.)

5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture III.)

5.30 p.m. Mr. J. Haantjes, "A Dutch Play of Mary Queen of Scots."

THURSDAY, FEBRUARY 21..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Carpenters, Worshipful Company of, Carpenters' Hall, Throgmorton Avenue, E.C. 8 p.m. Mr. Raymond Unwin, "The Housing Problem and how it has been met."

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part II: The Dependence of Quantum Efficiency on Wave Length." (2) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part III: A Comparison of the Thermal, Photochemical and Electrical Decompositions, and a General Theory of the Change." (3) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part IV: Fluorescence and Photochemical Activity." (4) Messrs. A. T. Dann and W. Davies, "The Reactions of Nitrosulphonylchlorides. Part I: The Reaction of Hydrazine Hydrate with o- Nitrosulphonylchlorides."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Dr. K. Ott, "The Erection of the Mechanical and Electrical Part of the Shannon Scheme."

L.C.C. The Horniman Museum, Kingsland Road, E. 7.30 p.m. Mr. L. A. Turner, "English Decorative Plasterwork."

Mechanical Engineers, Institution of, at Queen's Hotel, Birmingham, 6.30 p.m. Mr. W. B. Challen, Chairman's Address.

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m. Mr. W. Cullen, "The Possibilities of Reviving Non-Ferrous Metallurgy in Great Britain." (Resumed Discussion). Mr. C. R. Julian, "Some Notes on a Tunnel driven at Rio Tinto, Spain."

Oil and Colour Chemists' Association, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. T. Wilson, "The Fresco Ordeal: its Chemical and Artistic Implications."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. A. O. Rankine, "Physics in Relation to Oil Finding."

University of London, at the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Mr. Harold J. Laski, "Thomas Hobbes."

At King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War: (Lecture II)—The Elementary School."

5.30 p.m. Dr. Edgar Prestage, "D. Francisco Manuel de Mello, a Portuguese and Spanish Classic."

5.30 p.m. "Czechoslovakia." (Lecture VI.) Dr. R. W. Seton-Watson, "The Slovaks—Then and Now."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture V.)

At University College, Gower Street. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture V.)

5 p.m. Mr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture VI.)

5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: a Course for Laymen." (Lecture I.)

5.30 p.m. Prof. Dr. Edmund G. Gardner, "The Italian Story of Merlin."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. James Laver, "Some Designers for Ballet."

FRIDAY, FEBRUARY 22..Engineering Inspection, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Mr. A. S. Grunspan, "Specification Notes and Good Practice relating to Concrete and Reinforced Concrete Work."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. Calderwood, "The Application of the Heavy Oil Engine to Yachts and Small Craft."

Mechanical Enginners, Institution of, at the Engineers' Club, Manchester, 6.30 p.m. Captain D. Richardson, "Welding Processes."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. George Baker, "Electrical Precipitation."

At the Engineers' Club, Manchester. 7.15 p.m.

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne. 6 p.m. Dr. G. W. Todd, "The Relation between the Properties of Engineering Materials and their Ultimate Structures."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) L. F. Stanley, "The Construction and Calibration of a Sensitive form of Pirani Gauge for the Measurement of High Vacua." (2) Dr. Charles H. Lees, "The Free Periods of a Composite Elastic Column or Composite Stretched Wire." (3) Dr. Allan Ferguson and Mr. J. A. Hakes, "A Capillary Tube Method for the Simultaneous Determination of Surface Tension and of Density." (4) Dr. E. H. Rayner, "A Demonstration of a Standard Electrostatic Voltmeter and Wattmeter, used for Measurements of alternating Currents at power frequencies at the National Physical Laboratory."

Royal Institution, 21, Albemarle Street, W. 9 p.m. "Lily-Stars of the Sea: How they fit their Surroundings."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture II.)

At King's College, Strand, W.C. 5.30 p.m. Mr. Vernon Rendall, "Shakespeare and Scott."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture I.)

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture VI.)

5.30 p.m. Dr. J. Howard Jones, "Hygiene of the Mercantile Marine." (Lecture I.)

SATURDAY, FEBRUARY 23..L.C.C. The Geffrye Museum, Forest Hill, S.E. 3.30 p.m. Dr. Bernard Smith, "Zermatt and its Glaciers."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Bullock, "Music in Cathedral and Collegiate Churches." (Lecture III.)

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FRIDAY, FEBRUARY 22nd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK

MONDAY, FEBRUARY 25th, at 8 p.m. (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, "Thirty Years' Experience of Industrial Maladies." (Lecture II.)

TUESDAY, FEBRUARY 26th, at 4.30 p.m. (Dominions and Colonies Section.) DR. H. J. VAN DER BYL, Chairman, South African Iron and Steel Industrial Corporation, Ltd., "The South African Iron and Steel Industry.". SIR WILLIAM J. LARKE, K.B.E., Director, National Federation of Iron and Steel Manufacturers, will preside.

Tea will be served in the library before the meeting from 4 o'clock.

WEDNESDAY, FEBRUARY 27th, at 3 p.m. General Meeting in connexion with the Fund for the Preservation of Ancient Cottages. THE RIGHT HON. J. RAMSAY MACDONALD, M.P., will preside, and the speakers will include MR. G. K. CHESTERTON, LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., SIR GEORGE SUTTON, Bt., Chairman of the Council, and others.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

WEDNESDAY, FEBRUARY 27th, at 8 p.m. (Ordinary Meeting.) A. F. SUTER, "East Indian Copals and Damars." J. G. WATSON, Forest Economist of the Forestry Department, Federated Malay States, will preside.

COUNCIL.

A meeting of the Council was held on Monday, February 11th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Atul C. Chatterjee, C.I.E.; Sir Edward Gait, K.C.S.I., C.I.E.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Mr. John S. Highfield, M.Inst.C.E.,

M.I.E.E. ; Col. Sir Arthur Holbrook, K.B.E., M.P. ; Major Sir Humphrey Leggett, R.E., D.S.O. ; Sir Reginald A. Mant, K.C.I.E., C.S.I. ; Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S. ; Sir Richard Redmayne, K.C.B. ; Mr. Alan A. Campbell Swinton, F.R.S., and Mr. Carmichael Thomas, with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society :—

Angus, Roy Alexander, Toronto, Canada.
Barrow, George Curzon Romaine, London.
Bason, Albert, Macclesfield.
Cairns, Harry Lister, Winnipeg, Canada.
Chanler, Albert, London.
Cumberbatch, Elkin Percy, M.A., M.B., M.R.C.P., London.
Dash, William Gerald, Weston-super-Mare.
Denson, William Henry, J.P., Chester.
Farnsworth, Frederick D., Fort Fairfield, Maine, U.S.A.
Fisher, Mrs. W. Rowland, Bourne End, Bucks.
Forbes, Mansfield D., M.A., Cambridge.
Hussain, Sh. Manzur, Loughborough, Leicestershire.
Huttinger, William Reynolds, Lansdowne, Pa., U.S.A.
Lahiri, S. K., Calcutta, India.
Londt, William Edward, Port Elizabeth, South Africa.
McDonald, Edward T., Chelmsford, Essex.
Pearson, Mrs. L. K., London.
Railing, Adolph Harry, D.Sc., Sutton Coldfield.
Richardson, Captain Leslie, Menton, France.
Sachs, Leo Ferdinand, London.
Schelling, Mrs. Henry, New York City, U.S.A.
Seeler, Edgar Viguers, Philadelphia, Pa., U.S.A.
Yeaman, John Alexander, W.S., Edinburgh.
Yorke, Algernon J., Kingstonbridge, Sussex.
Ziegler, Carl A., Philadelphia, Pa., U.S.A.

It was reported that H.R.H. the President had nominated the Hon. Sir Charles Parsons, O.M., K.C.B., F.R.S., a Vice-President of the Society.

Lord Bledisloe, K.B.E., was elected a Vice-President of the Society.

Further consideration was given to the question of the award of the Society's Albert Medal for 1929.

Arrangements for the first Annual General Meeting of subscribers to the Fund for the Preservation of Ancient Cottages on February 27th were considered and approved.

Copies of the prospectus of the Sixth Annual Competition of Industrial Designs were laid on the table, from which it appeared that over £2,000 would be offered in scholarships and prizes this year.

A report of the British Science Guild on the Reform of the British Patent System was considered and generally approved.

In view of the greatly increased number of entries for the Society's Examinations, it was resolved to reconstitute the Examinations Committee

and to secure on it the representation of the principal bodies interested in Commercial Education.

Mr. A. Kahn, Chief Examiner, was appointed to represent the Society at the International Congress of Commercial Education to be held in Amsterdam in September next.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 13th, 1929. MR. H. V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, in the Chair.

A paper on "Fruit Pollination in relation to Commercial Fruit Growing" was read by MR. CECIL H. HOOPER, F.L.S., of the South-Eastern Agricultural College, Wye.

The paper and discussion will be published in the *Journal* on April 5th.

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JANUARY 23RD, 1929.

THE RT. HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D. F.R.S., P.S.A., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said the subject was that of Museums and Education—one with which Sir Henry Miers of all people was best qualified to deal. Many years ago Sir Henry Miers had been connected with the Natural History Museum. Subsequently he had acquired a very well-recognised place in the world of science. Then, as head of a great modern university in the North of England, he had rightly come to be looked upon as protagonist of higher scientific education. Since then it had fallen to his lot to inspect and to report upon every single museum in the British Isles. That was a feat of courage and endurance which few would dare to try and emulate. Sir Henry had accomplished it, however, and therefore could anybody be better qualified than Sir Henry to deliver a lecture upon Museums and Education?

The following paper was then read:—

MUSEUMS AND EDUCATION.

By SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., F.G.S., F.C.S.

If the walls and roofs of all the museums of the country were to become transparent a spectator gifted with a miraculous power of vision and able at

one moment to see all that they contain, would perceive an extraordinary display of miscellaneous things: natural history collections, works of art, pictures, furniture, antiquities: exhibited in cases or stored in drawers. In some places they would appear to be beautifully selected and displayed, in others they would be a mixture of incongruous objects. But, taking the museums together, he would see that they contain, together with much rubbish, a vast mass of valuable material, an enormous assemblage of rare, interesting and beautiful things from all parts of the world, and relating to all the ages.

Looking at the country as a whole, he would see two parts of the British Isles in which this material is closely concentrated, namely, the London district, and Lancashire with the West Riding of Yorkshire. In other parts of the country he would see large areas in which there is none.

Turning first to the more important and prosperous museums, especially in the larger towns, he would see visitors wandering about in a somewhat aimless fashion. At certain times of the day there would be crowds; at other times, unless it was a wet day, they might be almost deserted. The National Museums in London, Edinburgh, Cardiff, and Dublin, would contain many visitors during almost the whole day. In these, and in only three or four of the others, guide lecturers would be conducting parties of serious visitors and explaining exhibits to an attentive audience, but even here some of the galleries would be deserted.

In a fair number of museums a class of school-children might be hearing a lecture from their teacher, or from the Curator, and busily making notes and sketches of exhibits. In a few, students from art schools would be making copies.

Here and there would be seen persons engrossed in the examination of some particular object. In a few of the more lively institutions there might be quite a crowd round some new or exciting exhibit, because it had been described in the local press. The Curators would probably be occupied in dealing with enquiries; only in the National Museums, and in half a dozen of the local museums, would members of the staff be seen in their work-rooms engaged in research.

Turning his attention to the less important and less prosperous museums, our observer would find such signs of activity comparatively rare; in many of them and during a considerable portion of the day, the rooms would be deserted. A general air of stagnation would be apparent; visitors would come and go without much evidence of interest. They would receive little or no help towards understanding the exhibits; they would be gazing at rows of things of no interest to them, over-crowded and sometimes very badly lit; there would be no one to apply to for information.

One museum would be empty save for a family of children with their nurse wandering among cases full of fossils and flint implements, until their mother, who had brought them in from the suburbs and deposited them there, should return from her shopping.

In another a group of tawdry girls would be using the glass of the mummy case as a mirror in order to beautify their complexions.

A third would be deserted, the caretaker would be asleep, and the side rooms would be locked lest stray children should get into them unobserved.

Turning his eyes to the worst and most neglected museums of all, he would see dark and dilapidated rooms with old cases full of decaying curiosities, among which he would descry a certain number of rare and valuable objects perishing irretrievably. One would have its cabinets and drawers locked with keys that cannot be found; another would have a dismal room closed to visitors because its floor is unsafe; in a third the table cases have been stacked in a corner to make room for a whist drive. Needless to say, such museums have few, if any, visitors.

Prying thus into the contents of the museums of the British Isles in a general survey our keen-sighted observer would probably be led to ask himself why so much of their valuable material is not being used. He might ask why, in most instances, the exhibited objects are so hopelessly crowded together, and why the majority of visitors drift from room to room without more than a passing interest.

If he were able at the same time to see the contents of the libraries of the country, he would observe a marked contrast. In most of them, and during a great part of the day, there would be numbers of persons in the reading and reference rooms, and many readers in the general library (especially if it possessed the open access system) selecting books to take home with them; on some afternoons in many libraries he would see eager crowds of children searching the books in the children's room. Everyone would be there with a purpose. He would also see, in many parts of the country, motor vans delivering books to schools and other centres in the rural districts.

In other words, he would recognise at once that there is an organised library service throughout the country, that a large proportion of the books are in constant use, and that all of them are stored for the purpose of being used as soon as required. He would be struck by the great difference between them and museums where there cannot yet be said to be anything like a national service, and where the visitors are for the most part strangers to the district or town, and are mere sightseers, half of whom make little or no personal use of the treasures that they contain.

Please understand that the picture which I have drawn is no fanciful one; everything that I have mentioned, or that I shall mention later, has been seen by myself within the last two years; anyone who has had a similar experience can easily understand why, in so many quarters, museums have a bad name; why the very word museum suggests to many people stuffy, overcrowded and uninteresting rooms that breed weariness and headache; and why they are so little known to the public.

It has been my habit in visiting towns to ask persons in the streets the way to the museum, with the object of discovering what proportion of them know anything about it. In one town I spent more than an hour in the evening in this pursuit before I discovered anyone who knew of its existence, and he was a boy who, after saying that he had never heard of one, ran back to add that he believed there was a case of birds on the staircase in the library. There was, in reality, quite a considerable natural history collection filling a large room in the library building.

In another town many people, including the policeman on point duty at the main cross-roads, assured me that none existed, and he was surprised when I returned in half an hour to tell him that I had visited it. Adequate street notices directing the visitor to the museum are rare in most places.

In a third large town I went to the address given me by the Town Clerk, described as an Institute with a considerable museum, only to find that the latter had ceased to exist five years ago.

In such places, and in many others, the museum clearly plays no real part in the life of the people; it is not regarded as one of the assets of the town.

Those who suffered in childhood from enforced visits to one of the old fashioned and more dismal may be forgiven for a lifelong dislike to all museums. If, however, they will correct their impression by a visit to a really good museum of the present day they will see how attractive and useful they can be made if administered by a good Curator and an enlightened Committee of Management.

The sight of eager children crowding round the exhibits in the Science Museum, or listening to a talk in the London Museum, or entering gleefully one of the more attractive provincial museums, will prove to such critics that, at any rate in some places, a new generation is growing up to whom the name has a very different meaning; and one of the most encouraging features of the situation is that the children of this new generation are taking their own parents to enjoy what they have been accustomed to shun.

There are bright spots even among the poorest museums—collections of local antiquities or of natural history specimens made and arranged by experts and enthusiasts, or storehouses of material well exhibited for the instruction of children and other visitors, who do make good use of them.

Why, then, with such great possibilities before them, do the museums of the country on the whole excite so little interest?

Why can they not all be brightened up and made useful? What is the disease from which so many suffer, and what is the remedy?

To answer this question one must look a little more closely into the nature of their contents and so learn something about the manner in which they have originated and the process by which they have grown.

In the first place, anyone who visits a good many of them, as I have done, will be struck by the similarity of their contents, and at the same time by their very mixed character.

In not a few of the older and more stagnant museums are still to be found the old outrageous types of "curios": such things as the two-headed calf, stones shaped like animals, or with queer markings like profiles, bottles containing unnamed reptiles, an albino bird, a boomerang labelled "savage weapon," a purse made out of a murderer's skin, the impressions of a coin in lava, a petrified bird's nest.

More recently, war relics have given an excuse for preserving fragments of aeroplanes and shells, battered helmets, and other odds and ends.

But, putting these aside and looking only at the more usual things, it will be seen that most museums, though they have the whole world to choose from, are exhibiting the same sort of objects and seem only to be trying to excel each other in the magnitude of their collections. Some curators, like some collectors, have become slaves to the lust of acquisition and the pride of possession. In my opinion the immediate problem for most museums is not so much how to get more material as how to make the best use of what they have got. Such things as stuffed mammals and birds, heads of game, butterflies, fossils, minerals, shells, glass, pottery, prehistoric and Roman remains, Egyptian antiquities, medals, coins and curiosities of all sorts form the staple exhibits. Sometimes the only objects related in any way to the town or the district are a few so-called "bygones." The watchman's rattle, the special constable's staff, the spinning wheel, the bone-shaker bicycle, antiquated umbrellas, hats, etc. These do, at any rate, belong to local history and are useful so far as they go.

If the visitor reflects on the nature of the main exhibits it will occur to him that they are precisely the things which it was the fashion to collect a hundred years ago. In those days a great many intelligent people made very considerable collections to gratify their own tastes, and those who travelled brought back innumerable curiosities from the countries which they visited. Most museums contain whole collections of this sort and their origin is pretty clear.

Look, for example, at the public museums owned by Municipal authorities. They usually began through a gift, or gifts, offered or bequeathed by their owners, and having been accepted by a public body, they were housed in some public building—at the outset generally the library—for lack of any more appropriate place.

In the first enthusiasm of a new venture, this nucleus has been increased by the addition of a number of gifts of collections or miscellaneous objects from private donors, and the museum, having been begun in this way, is continued by a process of miscellaneous accretion, even when it has ceased to be a room in a library and has a home of its own. Such gifts are not unusually of considerable magnitude and importance, and it would have been difficult for a town council to refuse them after once the museum was started on these lines. Even when a purchase grant has been made by the governing body, the policy of welcoming and accepting practically every gift has almost always been prevalent in the early stages.

The same process has generally prevailed in most other public museums, even those which were owned and administered by societies or associations. The result has been that, taken as a whole, the public museums of the country are remarkably like one another in general, and very few are particularly appropriate to the locality in which they have been placed. Their character has really been determined by miscellaneous donors. With most of these museums it is perhaps natural that in the early stages they should concentrate on mere acquisition; the necessity of filling empty rooms was the main stimulus; with the result that often the same process has been continued when it is no longer necessary, even when the space is beginning to be cramped. In fact, it may be stated in general terms, that most of the museums have suffered from the mere practice of acquiring exhibits (or even collections that cannot be exhibited) without any definite idea of the purpose to which they can be applied. There has been no clear policy to regulate the growth of each; and yet it is evident that the conditions vary so much between different towns and different districts that to be of real service the museum should adapt itself to the needs of its locality.

There is no reason why the same sort of museum should be established in a great city, a small town, and a village; in a manufacturing centre or an agricultural district; in a maritime port, or a seaside resort; if it is to render the greatest public service, it should clearly be appropriate to its neighbourhood, and should pursue an appropriate policy. If there is no particular characteristic that dictates the future of a museum required in a given district, the place has, at any rate, a history of its own, natural resources, or local conditions, all of which can be illustrated in the museum, and make it a centre of real interest to the neighbourhood.

To all the general statements which I have made there are notable exceptions; many of the museums situated in places where there have been historic or prehistoric discoveries disclosed by the archæologists have begun to concentrate to some extent on the prehistoric remains, or on the historic furniture and architecture, etc., of the neighbourhood. Some few have even begun to get rid of the often overwhelming and miscellaneous collections which have nothing to do with these.

Again, it is gratifying to notice that such places as Liverpool and Hull have begun to organise shipping exhibits; that Nottingham, Norwich, Stoke, Worcester, Luton, Leicester, and others deal with the industries for which the towns are, or have been, famous; that old houses and historic mansions which enshrine the history of the district have been preserved and in many cases appropriately furnished, as at Bolton, Stratford, Norwich, Ipswich, Birmingham, Bradford, Leeds, Shoreham, Southend, and other places; and that the houses inhabited by distinguished men, such as Shakespeare, Milton, Johnson, Cowper, Carlyle, Hogarth, Keats, Wesley, and others, have been preserved as far as possible in the original stae. A few museums have

definitely devoted themselves to some special purpose, and have an idea to inspire them: for example, the Educational Museum at Haslemere, and to some extent that at Ancoats in Manchester; the Home Office Museum; the Pitt-Rivers at Oxford, the Horniman and the two Wellcome Museums in London.

One must note, of course, that there are a considerable number of University and professional museums, and some belonging to societies or associations, which have been definitely established for the use of students, and a certain number, such as Lord Rothschild's Zoological Museum at Tring, the Bryant and May Collection in Bow of appliances for the production of fire, the old Ashmolean Museum at Oxford, were designedly limited to a special subject.

There are many signs of improvement in the general situation; but, when all is said, it must be confessed that the large majority suffer from over-exhibition, lack of policy, and the fatal habit of accepting miscellaneous gifts, so that of the service which they might render throughout the country a very small part is actually fulfilled by them.

The title of my lecture is "Museums and Education," and it is from the point of view of education that I must consider a little more closely the question: Why should museums exist?

Numbers of towns, large as well as small, have none, and they seem to be no worse for its absence. (In my report I gave a list of 112 towns with a population over 20,000 which had none; it is true that some of these are within easy reach of towns that are supplied, but this is not true of the majority).

First, what is the use of a museum? A partial answer is that to most people, grown-up as well as children, sight is everything; a mere description without a vision of the thing described falls on deaf ears; even a picture of it does not make full appeal to the eye. Some persons have minds so constituted that this is the only way in which they can acquire real knowledge; they are not readers, they have no eye for diagrams, but they are keenly alive for actual experiences.

Even to people who are fond of reading and of pictures, nothing can replace the interest of the genuine thing. Learning is enlivened and made far more effective if visible objects are brought together with a purpose. In subjects like natural history this is obvious; in ordinary history it is equally true. Look, for example, at the room illustrating Greek and Roman life in the British Museum, or the exhibits at Huddersfield explaining the history of the settlement of that district by its early inhabitants; or the history of discovery as illustrated in the Science Museum.

But in addition to this is it not true that only in our museums are to be found the visible materials of history, science and art; the things about which we read but which we could only otherwise see by making long journeys? Many, indeed, have perished and are only preserved in museums. Bear

this in mind and the question is not, How can the museums be of service in education? but rather, How can education get on at all without the museums and the first-hand knowledge which they supply? They are not filled with dull things that have no concern with ordinary life and learning, as some people imagine; they abound with material that is the very foundation of knowledge in almost every conceivable subject.

The educational question is beset by one great difficulty. Most educational institutions are designed to serve some particular class of people or to fulfil some particular purpose; they are meant for children, or for students of a certain age, or for persons with a certain aim before them. Museums and Art Galleries, though their educational possibilities are enormous, resemble the broadcaster in that they serve a vast unknown public; they are frequented by persons of all ages, types and classes; most of these do not say what they want, and it is impossible to ascertain what knowledge they have gained, or even how far their curiosity has been satisfied.

If, however, visitors can have their imagination stirred; if the spirit of enquiry can be kindled and satisfied, then the exhibited collections are doing real educational work.

In many museums of the country there are learned and hard-working curators doing their best, often handicapped by miserable pay, lack of sympathy and abundance of misunderstanding, but doing their best to make their collections attractive and useful. I have said a good deal about the defects of the worse museums, but much might also be said about the treasures and their effective display to be found in the better museums and art galleries.

The new art of window dressing in shops is cultivating a taste for spectacular display, and a good museum exhibit can compete even with the shop window; it also makes its appeal to the eye and relies upon its power of attraction. The shop window serves its purpose when it tempts the gazer to come in; the museum when it tempts the visitor to think.

The term "curio" is one of reproach; but, after all, it only means an object which stands alone, out of harmony with its surroundings and therefore unable to serve any purpose, whereas it could, in the proper place, be interesting and educational. The coin in lava or the special constable's staff are of no use to the ordinary visitor unless they excite interest and prompt a question which is answered by the adjoining exhibits or by a good label. Even a rare animal in a magnificent case is only a curio if it stands alone and leads to nothing; visitors admire it and pass on; and though it is true that to encourage a love of beauty is one of the great objects of a museum, as well as of an art gallery, something more is needed.

Everyone who has been taken through a museum, or even one of its rooms, by an intelligent curator, knows how interesting it can be made by him in a few minutes; but few visitors can enjoy this privilege, and very few museums can afford the inestimable benefit of a guide lecturer.

Failing this, and apart from the value of a museum as a storehouse of material for special study, everything clearly depends on the manner in which the objects are selected, exhibited and explained.

And this brings me to a second question: What should a museum try to do, and how? For whose service is it designed?

Consider, for example, the Municipal Museum in a large town with a large space for exhibits, within easy reach of a good library and probably situated in a much frequented quarter. This has to serve, in the first instance, the needs of ordinary visitors, who come in, often with no particular purpose, and only rarely with the object of seeing any particular thing. From the enquiries which I have made it seems to be generally the case that about 60% of these visitors are not inhabitants of the town itself, and in these easy days of transport a very considerable number are mere passers-by, who pay quite a short visit.

In the second place, there are the needs of the schools of the district to consider. Sometimes school visits are organised in which classes are under the guidance of their own teacher, or lectures are provided for them. In some instances the museum is able to lend specimens to the schools and even send out boxes with sets of objects specially arranged and labelled for their use.

In the third place, such a museum has to consider the needs of collectors, experts in special subjects, and persons who come to make quite definite enquiries; and, lastly, there may be persons who wish to make use of the resources of the museum, and conduct researches within its walls. This last class is, of course, rare, and in most places hitherto non-existent.

Is it not obvious that every exhibited object should be displayed for the advantage of one or other of the different classes of visitors who may be expected? Let us consider what this means.

First, with regard to the ordinary visitor: in my opinion a quite definite policy should guide the curator and his committee. The exhibited collections should, if possible, relate mainly to the history, the nature and the resources of the town or district, and other exhibits should, so far as he is concerned, be subordinate to these, and should serve to illustrate them whether by comparison or contrast.

It is most important that the visitor should on entering the museum be greeted by exhibits which arouse his interest, something characteristic of the general collections which he is about to see. A case containing latest acquisitions is generally useful in challenging the interest even of residents to whom the collections are fairly well known. An exhibit relating to something of contemporary or local importance can be very attractive. Very few museums took advantage of the eclipse the year before last.

Further, each museum should have a character of its own. This will depend on the curator, and will be one of his chief cares. If it changes with successive curators, so much the better.

For the visitor who is not a resident there should be plenty of direction-labels

and plans, clearly indicating the arrangement of the sections and the order in which they may best be visited. The larger the museum, the more important is this. It is pathetic to watch the attempts of a casual visitor in a large museum to get something definite out of a short visit.

In his tour through the collections he may, for example, pass suddenly from an exhibit of china or glass to cases containing flint implements and prehistoric remains, and from these to shells. Unless there is something to prepare him for the shock he can with difficulty turn his mind from one age and subject to others which are totally different, and he needs some well-chosen specimens arranged and labelled so as to explain what is coming next, before he is overwhelmed by it. His visit is a series of such shocks, and I believe this to be the main source of museum headaches. (This is equally true of many picture galleries, where artists and schools succeed each other with bewildering rapidity and without explanation, or are inextricably mixed.) No wonder that he contents himself with a hasty search for something exciting.

Where the sections are large there should surely be at the beginning of each a case or series of cases containing a short, well-spaced, well-labelled introduction to the section. For a first visit, or for a chance visitor, these introductory series give almost all that is required, but they should be of such a nature as to stimulate in him the wish to see more of the collections.

I need not refer to the great value of guide-books, "What to see" leaflets, special handbooks, photographs and postcards, such as are issued by many of the better museums. The large sales which they generally secure shows how they are appreciated by the public. Lectures and qualified guide lecturers should be encouraged and every museum should, where possible, have a lecture room The work of Lord Sudeley and, since his death, of the Sudeley Committee has roused much interest in these matters.

We come next to school children or adults who seek educational guidance. It is in particular for this class that these introductory series should be specially designed.

When the educational use of a museum is discussed one is too apt to think of this merely in its application to school children. In reality its educational responsibility relates to grown people as much as to children; like a library, the museum exists for adults as well as children to use at their own times for voluntary self-education. That is why the exhibits must be not only well chosen but also well explained for both. The construction of lucid labels is a very difficult task and one which requires much care and thought. Moreover, they must be conspicuous though not aggressive, and must be placed where they can be easily read. This is a particularly difficult problem, where the objects are works of art exhibited largely on account of their intrinsic beauty, and where a label, unless cunningly designed, may break the harmony of the display.

I would not wish, however, to lay down any fixed principles for educational exhibits or loans to schools. This is a matter in which the curator, with the help of school teachers, should devise his own methods in order to meet, as far as possible, the special needs of the schools and the district. It is always a help and encouragement when references to the books which may be consulted in the library are placed near the exhibits.

It is curious that collections set apart for the enlightenment of children, as at Bethnal Green and at the Tollcross Museum in Glasgow, should be so rare; they might be very useful, and children might be encouraged to contribute to them by collecting.

Visitors belonging to the remaining categories, *i.e.*, the collectors and researchers, should find what they want in systematic collections following the introductory series, and in the reserve collections; in these last the objects should be just as well arranged, and well labelled, and as accessible as those in the exhibition cases.

To carry out a full scheme on these lines would involve, in a great number of large museums, very radical changes. The exhibited portions would have to be drastically weeded out, and perhaps a majority of the specimens transferred to reserve, or exchanged away. This is, to some extent, being done in a few museums, and it is most instructive to compare those parts of such collections which have been thinned out and re-arranged, with those parts in which the old congestion prevails.

In almost every museum, however, a beginning might be made, and the process be continued as opportunity occurs.

To preserve an atmosphere of vitality, it is of the highest importance that constant change should be taking place in the exhibited collections, whether by the transference of material from reserve to the show cases, or by means of temporary exhibits obtained by loan from other museums. Everyone knows how an art gallery in which the same pictures hang in their accustomed places year after year, is liable to become stagnant, and how much it is re-vivified by the appearance of a loan collection of special exhibits from time to time. In a museum it is more difficult to clear a room and make space for a special loan collection; the objects are also more difficult to transport than pictures. Still, a great deal may be done by the temporary exhibition of special objects that fill a gap in the ordinary collection, or make them, for the time being, more interesting and useful. The Parliament and Premiership Exhibition at the London Museum is a recent example. A very helpful part is played by the cases received on loan from the Victoria and Albert Museum in those museums which share in its distribution system. It is generally found that the advent of a new case attracts an increased number of visitors.

With regard to research, although at present very little is, or can be, done directly, the mere existence of reserve collections is of great help to the local collector or enquirer, and this is especially true of museums already associated

closely with such bodies as archæological and natural history societies. If these can actually hold their meetings in the museum's premises, and organise visits to it, opportunities will gradually grow up for research into local history and conditions, specially, in the first instance, by organising a regional survey. Work of this sort has a high educational value.

Next, with regard to museums in small towns or villages, it will almost certainly be wise for the great majority to specialise entirely, or almost entirely, on (*a*) local interests, and (*b*) educational purposes. If collectors and investigators cannot have their difficulties solved they should be sent on from the small town or village to the large and more central museums. A really good local collection, and one which becomes a delight to the inhabitants of the neighbourhood, is of far more use in such places than any number of miscellaneous specimens, such as the foreign material, the ethnographical and archæological lumber from distant parts of the world, and the travellers' gifts, which so often cumber these small museums. In most of them a very radical reform is needed.

The museum should, where possible, act in close co-operation with the library ; this need is particularly obvious in the case of technical and commercial libraries. Librarian and curator can be of the greatest assistance to each other. The arrangement by which they are the same person, though very usual, I can only regard as a temporary expedient, at any rate in the larger towns.

It will, however, be impossible for the country to develop anything like an organised museum service until each museum is able and willing to help others to supplement their needs. If the vast mass of material which is not wanted in each museum could be transferred or lent where it can be used, and if the larger museums could institute a system of loans or circulating collections to the smaller towns and villages, the existing material which at present serves no special purpose, might become effectively useful throughout the whole country.

It is difficult to see what is gained by occupying valuable exhibition space with a rare collection of type fossils or of Peruvian antiquities in a museum where there is no prospect of their ever being used.

For many years past the deficiencies of the museum service have been very widely recognised, and there have been constant complaints concerning the needs of local museums and their difficulties in obtaining the support which they require in order to carry out even their duties to the district. The demands for an enquiry into the whole system have been frequent, and it has been more than once suggested that a Royal Commission should be appointed for the purpose. Conscious of these claims the Carnegie United Kingdom Trust summoned in June, 1926, a Conference of the various bodies likely to be most interested, in order to discuss the situation ; the conference was attended by persons representing many interests, and it was suggested that an enquiry

should be held by the Carnegie Trustees themselves. I was invited to make this enquiry on their behalf, and visited a large number of the museums of the British Isles. I submitted to the Trustees a Report which was published in April, 1928, and which has been widely circulated to museums and to persons interested in them.*

It will be remembered that the Carnegie Trustees pursued a similar course when they invited Professor W. G. S. Adams to inform them on the Library provision of the country, and received from him a Report which was published in 1915. It will be remembered, also, that as the result of this enquiry and the subsequent action on the part of the County Councils and the generous assistance of the Carnegie Trustees, the whole system of County Libraries was instituted, and that this brought the library service of the country, for the first time, within reach of the rural population. The library service of the country has been strengthened by two other factors : first, the increased power and authority of the Library Association, which now represents every important library in the Kingdom, and, second, the establishment of the Central Library for Students. This library, which was originally instituted to lend books to members of the Workers Educational Association, and the University Tutorial Classes—in other words, to supply the needs of poor students—became, with the help of the Carnegie Trustees, a very important organising centre. It is now performing an even more striking service than that for which it was originally constituted. It has associated with itself a large number of the special libraries of the country. Any student needing a book not to be got in his district can now apply to his own local library. This in turn applies to the Central Library, which gets the book for him from one of the affiliated institutions. This really constitutes the first attempt to organise special libraries, such as those belonging to scientific, literary and artistic societies, for public service.

Turning now to the museums, it will be seen that there is, at any rate on the surface, a remarkable parallel. There is a Museums' Association, which at present only represents about one quarter of the museums of the country. Until it becomes as fully representative as the sister association, it can hardly expect to be as effective as the latter has become. The rural population derives no more benefit from public museums than it derived from public libraries before the institution of the County Libraries, and there is no more co-operation between individual museums than there was between individual libraries before the institution of the Central Library. It is, therefore, not surprising that some of the suggestions to which I was led in the course of my enquiry closely resemble the improvements which have been instituted into the library service.

*The fact that a Royal Commission was appointed in July, 1927, to enquire into the National collections situated in London and Edinburgh made it advisable for me to exclude the National Museums from my Report, and prevents me from saying much about them here.

The Museums Association should be strengthened; it should become fully representative; it should be able to secure the consideration of better scales of payment for curators and their staff; it should be able to establish a standard of education to be attained by all those who enter the museums' service; local authorities should endeavour to co-ordinate the activities of the museums within their area, and encourage them to contribute by loans and personal assistance to a system of travelling collections to serve the educational needs of rural districts; museums, like libraries, should, where possible, be open in the evenings.

These recommendations will be found in my Report. It has frequently been urged that there should be some central or national distributing agency which could organise the loan of much needed exhibits to all the important Public Museums of the country. It has generally been assumed that this would involve a great central collection established for the purpose. Sometimes it has been thought that the National Museums themselves should be constituted the central lending agency, and should send out what they can spare from their own treasures on loan to the various museums; in fact, that they should carry out on a larger scale the work that has been done by the Loan Department of the Victoria and Albert Museum, or even that the work of that Department should be extended so as to include all sorts of museum objects. At present the Victoria and Albert sends out cases of exhibits relating to applied art to about eighty museums, which keep them for about fifteen months until their contents are changed. These cases, however, do not contain objects selected from the great collections of the museum, but come from a special store kept for loan purposes.

The Victoria and Albert also administers a small grant of a £1,000 a year from which other museums are assisted to purchase desired objects; and, further, it sends out loan collections of Decorative Art to no less than 550 schools in the British Isles for educational use.

The question of gifts and even of loans between museums is complicated by the fact that those whose material is constantly being used for purposes of research and reference possess comparatively little that can really be spared. Among National museums the British Museum is, of course, the most conspicuous example; University museums and a few of the great provincial museums to some extent come into the same category in respect of both research and teaching material.

I cannot help thinking that a liberal system of loans, between the National, the larger provincial, and the smaller local museums which are really endeavouring to do good work, would be very helpful. And exchanges, which might when necessary take the form of permanent loans, would be useful to almost all the museums of the country.

But to carry out any such scheme of organisation means a complete change in the attitude of mind on the part of the public, of the curators, and of the administering Committees.

The public must learn to take a pleasure and a pride in their museums, to use them and to give them their support ; the curators must resolve not only to make the best possible use of their materials, even to the extent of sacrificing some of them, but must consider their duty to the country as a whole and be prepared to give and to exchange as well as to amass ; the Committees must get the best available curators, pay them adequately and supply them with assistance.

If I seem to have criticised unduly the curators and administrators, let me add that, in my opinion, the general public really deserve most of the blame. The museums, with all their treasures, belong, for the most part, to them, and it is their fault if these are not used as they should be. Let people go round and ascertain how far they can learn from their own museum. Let them see that it becomes an institution of which they may be proud.

The real test to be applied to the exhibited collections is to ask concerning each object : Why is it here, and what purpose does it serve ? If this question cannot be satisfactorily answered that object had better be turned out.

An unlabelled object, or a mere duplicate, or one that cannot be seen or understood, if placed among the exhibits, is not only useless, but is a positive harm to the museum.

The test to be applied to the museum as a whole is to ask the question : What is the idea behind it, and what is its aim ? If this question cannot be satisfactorily answered it had better be closed.

Great systematic collections should only be in places where they can be used, such as the National or the University Museums, or in such as have a trained staff ; there they can be at the service of experts and specialists, or be used for teaching purposes.

So long as mere collections of objects unexplained and unrelated to each other exist only to weary the visitor, so long will the public be prejudiced against museums. The manner in which they are misunderstood is indicated by the offers which they occasionally receive. Even a great National Museum has been offered " two joints of meat cut and hung on the day Queen Victoria was crowned ; " and donors have proposed to present objects to it which were stated to be only fit for a museum.

My report to the Carnegie Trustees also called attention to the extraordinary deficiency in certain types of museums, such as Agriculture, Hygiene, Shipping, Industry, Commerce, which would certainly appeal to large classes of the community, if not to all.

Again, the absence of any worthy Museum of Sculptural and Architectural Casts is a disgrace to the nation. It is true that there are collections at the Victoria and Albert, the British Museum, the Crystal Palace, in addition to the teaching collections at Oxford and Cambridge, but there is nothing to compare with many to be found abroad. In casts of Greek and Roman

sculpture, for example, we are far behind, not only Berlin, but such towns as Munich, Copenhagen and Boston. Except for its position no existing building seems to me better suited for a great collection of casts than the Crystal Palace.

There is one missing type which is particularly urgent and to this I would like to devote the few moments that remain to me.

Last year I visited the small town of Arnhem, in Holland. There, in 1912, an association was formed which collected material for a National Museum to illustrate the former life of the Dutch people. A large park was provided by the Municipality; it was decided to exhibit not only objects relating to the art, industries, occupations, and customs of the folk, but also the actual houses in which they lived.

There is now in this charming park a museum building containing domestic material and the other things usually known as "folk" exhibits, illustrative of peasant art and industry. In addition, dotted at intervals about the park, are old cottages and other buildings; these are in no case imitations, but are actual structures transplanted from different parts of Holland and re-erected in a new setting.

Here you may see, for instance, a seventeenth century farmhouse, with its thatched roof, its loft, its blue painted wattle walls, its fire hole in the ground, and its two tiny rooms, little more than cupboards, containing the looms at which its weaver inhabitants carried on their cramped trade. In another part you may see a fine tiled early eighteenth century farmhouse with its proper equipment and furniture; further on are waterwheels and windmills belonging to different periods and different types. You can go into them and see their antiquated wooden machinery. The cottages and other exhibits are numbered in order, outside each is a bench, and a receptacle for lighted cigarettes and cigars; there are no caretakers; visitors can wander through and see everything for themselves; there is an excellent guide-book.

The central portion of the park is cultivated, and contains the garden of a botanical society and one belonging to the pharmacists. There is an open air theatre for popular representations, folk dances, etc. The whole place is aptly called the "Open Air Museum."

This is only one of several such museums to be seen abroad, of which Skansen, at Stockholm, is the earliest. A similar one, for example, was started by private enterprise at Aarhus, in Denmark, in 1924.

In England there is nothing of the sort, and the houses and materials from which an open-air museum might be constructed are rapidly disappearing. It is not too late to save the few that remain if action is taken without delay.

Here and there, as at West Hoathly, at King's Lynn, at Thetford, and at other places, most interesting old houses have been secured by the enterprise of individuals, and have become museums of contemporary "bygones." Near Hull an ancient Tithe barn has been recently utilised for the same purpose. And

the Royal Society of Arts itself is doing a great work in purchasing old cottages and houses which are in danger of destruction, in various parts of the country.

But there is no real "Folk Museum,"* to depict the life of English people through the ages; old mansions and the treasures which they contain when they have been converted into museums perpetuate and enshrine the Fine Art of their periods, generally the property of the rich and in large part the work of foreigners. The Folk Museum would restore to our sight the work of our own countryman, and the conditions under which it was carried on; their industries and industrial art, their adornment and their architecture.

If public or private enterprise can find the means there should be a National Museum of this type situated in the London area, in some such site as the Botanic Gardens in Regents Park, or the sixty-six acres of ground surrounding Chiswick House, which has recently been acquired for the public.

Finally, to recapitulate, I have made a number of suggestions about needed improvements in the museum service; most of them involve largely increased expenditure, on improvements in buildings, on the provision of storage space, on increase of staff, on proper salaries for curators and their assistants, on guide-books, labels, lecturers, special collections; but I have not concealed my opinion that very imperfect use is made of the existing material, and that even under present conditions a great deal could be done by a widespread co-operation which does not yet exist. A local federation of museums in Lancashire and Cheshire is of recent origin, and is doing something; the museums of Wales are almost all affiliated to the National Museum at Cardiff; this is a beginning. Other local federations and affiliations would be welcome; but, in addition to this, all the museums of the country should combine for common action; they should make their Association a completely representative body by becoming members of it; they should authorise it to act on their behalf in organising a real museum service, and enabling them to assist each other; they should co-operate in seeing that all curators are properly trained; in stirring up public appreciation of museums and their work; they should enter into closer relationship with the Library Association. The County Councils should take in hand the extension of museum facilities to the rural areas, though for this, I am told, new legislation may be required. Collectors and donors should see that their collections go to museums where they are acceptable and where the best use will be made of them.

Except in a few conspicuous places, there seems to be so little pride in museums; the main mass of the public are scarcely conscious of the treasures that they possess.

I have immense faith in the great service that can be rendered by our museums; I am confident that they possess untold resources and vast possibilities, I believe that it is only necessary to stir the public imagination and they can easily be made one of the great educational forces in the country.

*The name "Folk Museum" is commonly used in two different senses: either as meaning an open-air museum of the sort which I have described, or a building containing exhibits illustrating peasant arts and industries such as the Scandinavian Folk Museum at Haslemere.

DISCUSSION.

SIR FREDERIC KENYON, G.B.E., K.C.B. (Director and Principal Librarian, British Museum) said the paper was a challenge both to all those who were connected with the museums of the country and to the public. The lecturer had made it quite plain that the country was not getting value for its museums at present. They were in a backward state, and a great deal of admirable material was being wasted. The public authorities responsible for museums had now to ask themselves the question whether they were going to make their museums live and useful institutions, if they were not so at present, or whether they were going to close them down. There were many museums which were doing excellent work, but there were a good many which were not. The key of the matter was in one sentence of the lecturer's, in which he said a change of mind was necessary. "Change of mind" was the proper translation of the word "repentance"; the authorities and the public had to repent of their previous attitude towards museums and to adopt a changed mind in future—to realise that there was a good deal to be got out of museums, and to think how they were to get the best out of the particular museum with which they were concerned.

The report of Sir Henry had been made for the Carnegie Trustees, and it was to be assumed, therefore, that that body was interested in the matter and would be prepared to consider what they could do to help museums in the future, as they had helped libraries in the past. The Carnegie Trustees had not bound themselves to the proposition that they were going to do anything; they had only so far said that they would, on the basis of Sir Henry's Report, consider whether there was anything practical to be done; and he took it that the conclusions to which they would come would depend a good deal upon the principle which they had followed in the past, namely, that they were only prepared to help those who were prepared to help themselves. Personally, he suggested that the best way in which the Report could be followed up would be if the Carnegie Trustees could see their way to appoint one or two permanent advisers or inspectors who would be ready to put themselves at the service of museums which wanted to improve themselves. The difficulty at present was that many local curators did not know how to make the best use of their material. It was a matter requiring a wide experience and a knowledge of other museums; and in many cases those individuals would be grateful for advice from an expert. Possibly the Carnegie Trustees would be prepared to assist those museums which were willing to progress along the lines pointed out to them by an expert adviser. The changes necessary would in all cases involve some expenditure, and local authorities did not command unlimited funds, but they might be willing to provide them if they knew those funds were going to be supplemented from an outside source. At any rate, he could not help thinking that there would be a great stimulus behind some such scheme as that. A second point was that of a central pool, or central loan museum. The lecturer had emphasised the value of novelty in exhibition, and for many museums the best form of novelty would be some kind of loan collection which they could hold for a time, combined with their own material, since the public were more likely to come when they knew there was something new to be seen. It was possible, if there were central advisers who had a general knowledge of the museums of the country, to do a great deal in forming loan collections out of the surplus material possessed by a number of museums. A good deal of material which was now described as waste material was waste material simply because it was good material out of place. It was no good looking to the national collections themselves as providing material for the sort of loan collections of which he was thinking. The

national collections, and the collections attached to the great universities, were entirely for educational purposes. It was a mistake to suppose that such institutions had any large surplus stores which were available for distribution. They required, for scientific purposes, to retain large quantities of material which the student could find there whenever he wanted to.

Mr. Eric Maclagan, C.B.E. (Director and Secretary, Victoria and Albert Museum) stated that his remarks would not in any way be in the form of criticism of what the lecturer had said—very much the reverse, because all those who had the welfare of provincial museums at heart realised that Sir Henry was probably the best friend which the provincial museums ever had had in the course of their history. Personally, he had often felt that the English provincial museums were unfairly criticised. Comparisons were made between them and the museums in the small towns of France, Germany or Italy ; but the conditions in England were completely different. If one came to analyse what was to be seen in the museums of the smaller towns abroad, it would be found in almost every case that those collections represented either, in the case of French local museums, the spoils of plundered churches and monasteries, or, as in the case of German and Italian local museums, the remains of local princely collections. Neither of those conditions prevailed in England. When there did exist an English museum which, for reasons of local archæology, had got first class material (Dorchester Museum, for instance) it was quite on a level with what was to be found in any museum on the Continent.

He thought it was not quite fair to compare museums with libraries in the way in which they were managed. It was much easier to run a public library than to run a museum. It was quite easy to buy good books, but it was not at all easy to buy good museum objects, which required not only money but knowledge. He quite agreed that a good deal of responsibility in the matter rested on the public. The public, once they entered a public building, seemed to become incredibly stupid. An ecclesiastical friend of his had told him that it was extraordinary how a congregation lost all their common sense the moment they entered the doors of a church ; and he himself had sometimes been tempted to suppose that a good deal of common sense was lost by the public when they entered the doors of a museum ; they were curiously slow at times to take advantage of the opportunities which were offered to them in provincial as well as in national museums. In a somewhat similar way, with regard to that most interesting problem of the relation of museums to children, he did think that a certain amount of blame must be put upon the educational authorities as well as on the museums. When he had been in America and Canada he had been very much struck at the way the actual lecturing to the children was, nearly always, done by school teachers and not by museum officials. There was a certain truth in the idea that what the museums mainly had to do was to supply the material, and that it was really up to the public and up to the instructors of the children to take advantage of that material, and that everything had not to be done by the director of the museum.

The Rt. Hon. George N. Barnes said he was one of those people who, up till that night, had known nothing at all about museums. He had always regarded them much in the way which had been described by the lecturer—as unattractive collections of unrelated articles, except to a specialist in some particular thing. It was, however, a tribute to the lecturer that he had made the subject most interesting, even to himself. In his own native town in Scotland he remembered the museum and the library being in one building, and they closely corresponded to the description given by the lecturer. The museum was a good place to hide oneself away from the madding crowd or to get protection from the inclemency of

the weather, whereas in the library one found an interest in the books. Sufficient had been heard that night to indicate that museums might be used as auxiliaries to education. It seemed to him that they might be of special value from a utilitarian aspect, and good use might be made of them in regard to the industries of the particular towns in which they were situated. After all, we lived in an age of specialisation, and in a town which specialised in some particular industry the boys could not be expected to be interested in old fossils and relics of bygone generations having no relation to the town's particular industry. Take the evolution of tools, for example. He had been in some of the museums in the industrial centres in the North of England, but he had found very little there to interest the people of those towns in the industries by which they got their living. One would think that in a town such as Manchester which lived on tools very largely,, there would be a museum showing the evolution of those tools from early times. Many other illustrations could be given. It seemed to him that if a museum was going to be made a real adjunct to the educational machinery of the country, something of that kind would have to be done to relate the museum of a particular town to the industry by which the people of that town got their living.

Colonel Sir Henry Lyons, F.R.S. (Director and Secretary, Science Museum) said the previous speaker had referred to museums representing their local industries. Though there were not a very large number of those, it was an aim which it was to be hoped would be largely extended. There was no doubt of the interest of the public in industrial and technical exhibits. At the Science Museum there was a series of such exhibits as those to which Mr. Barnes had referred, and he could assure Mr. Barnes that it was a very remarkable thing to see the way people from the North of England, who had come to London to see a cup tie, for instance, streamed into the galleries containing machinery and appliances with which they were familiar in their work, and inspected them with the greatest possible interest. That went to prove that those people would be glad to have a further development in that direction in their own local museums. That part of museum work was especially affected by what the lecturer had said on the educational side of the subject. Few things in technical museums were in the least attractive in themselves and consequently until the public was led to take an interest in them—that was to say, until they had some small knowledge of them—they would not really appreciate what they were there for. In museums of that class, as in any other, it was essential that information, carefully edited, should be placed within ready reach of all visitors. He only wished that the public, when they did visit museums, would be more critical, and would draw attention to things which either they found unsuitable or insufficiently attractive to them. It was not difficult to pick up a good deal of information by watching the public on a crowded day and to see where they stopped and looked at things, and where they did not. Where they did not stop at the right objects, there was usually something wrong in that particular place with the curator's arrangement, which could probably be modified, and modified effectively.

Mr. G. E. Dibley (East Gate House Museum, Rochester) asked if there were any statistics available in connection with the opening of museums in the evening for working people. It would also be very valuable if the lecturer could insert in his report a recommendation that municipal authorities should be advised to appoint really suitable persons to serve on their museum committees.

Professor Graham Wallas said he had only one suggestion to make, and that was with regard to the use of reproductions as part of a series of exhibits

Many museums had a single authentic coin which, if it was placed in a series of electrotype reproductions, would be of the greatest possible value. The same applied to stone implements. A single stone implement was of very little interest, but if it was placed in a series of exact reproductions showing prior and successive periods of the evolution of those instruments, it would be extremely valuable.

Dr. Francis A. Bather, F.R.S. (Late Keeper, Department of Geology, British Museum) said the author had brought rather an indictment against provincial museums, and those who managed them and those who visited them. He admitted numerous exceptions. When it was considered how that state of things was to be altered it was found that there was a vicious circle. In the end the lecturer had said it was the fault of the public. Why did not the public take an interest in museums? Because they were not interesting. Why not? It was not the fault of the curators. There were many such men and women who did their utmost to make their museums interesting. It was the fault of the committees. The committees were individually excellent people, but they did not get enough money. Why not? Because the public did not want to pay the money. Why not? So the whole thing went round and round in a vicious circle. What was to be done to get out of the difficulty? Everyone had hopes that the Carnegie Trustees would do something to break that circle. Sir Frederick Kenyon had made some valuable suggestions how that could be effected. Personally, he merely wanted to emphasise the fact that there really were a great many museum people in this country who did their utmost to make their museums interesting. Foreign provincial museums might, as Mr. Maclagan had said, be richer in material, especially of art, than corresponding museums in this country, but in respect to the educational use made of it the musems in the ordinary small provincial towns of the Continent were not anywhere near the same level as those in English provincial towns. There was not a single museum in France, for instance, which was doing anything like many English provincial museums in the way of instructing the public and of making the exhibits interesting to the public. Most of the museums abroad were excellent institutions for the specialist but did nothing for the general public. He urged school teachers to make more use of the museums, and, after a history lesson, to take their pupils to see the particular specimens of the period of history dealt with. For instance, if the pupils had been reading about Queen Elizabeth, it would add greatly to the value both of the lesson and of the exhibits in the museum if the teacher took them to have a look at the things in the museum which had some connection with the Elizabethan period. With regard to the Scandinavian open air museums to which the lecturer had referred, a Swedish friend of his had remarked to him, "What is the good of having an open air museum in England? England is already an open air museum. You have got these old houses everywhere. Do not bring everything together into one great museum. The objects are of greater interest when preserved in or near the places to which they belong."

Miss Marian Frost (Curator, Worthing Museum) said she happened to be curator of a small museum and of a library as well, and she would like to say that she thought the reason why libraries in this country were so much better run than the smaller museums was largely because of the assistance which the Carnegie Trust had given to rural library schemes, and also because of the fact that in earlier days Carnegie had given so much money for library buildings. There were many curators who would have their museums in very much better order if they had a little more money and room. With regard to the point of unsuitable objects in museums, in a small place it was extremely difficult to refuse unsuitable gifts as it might mean

the loss of a subsequent suitable gift. All curators of museums would like to follow the example of the beautiful museums in Copenhagen, where one picture or one bronze was put in a single room, but unfortunately they had not the space, and therefore had to crowd the objects together. As she had said, if curators had more money and more room, they could certainly make their museums very much better.

Sir Atul Chatterjee, K.C.I.E. (High Commissioner for India) said he had come to the lecture knowing very little about museums, but he had learned a very great deal during the course of the evening, not only from the lecture itself but from the most instructive remarks of the very distinguished speakers. From the point of view of a person who went round museums without knowing anything about the subjects displayed, he would like to say how much he had appreciated the lecturer's suggestion regarding labels. He had often seen things which he had not understood and about which he wished to know something, but in many cases there had been no useful labels attached to those objects for the instruction of ignorant persons like himself. That was a point which he thought should be attended to by all curators of museums. Another point which had struck him was the fact that no reference had been made to any museum which educated the people of this country in regard to the resources and the various details connected with the British Empire. There was, of course, the Imperial Institute, but all knew how deficient that was in many respects, and the present management under Sir William Furze were making most strenuous efforts to improve the condition of that institution ; nevertheless he could not help thinking that it would be a very useful thing if local museums all over the country gave more attention to displaying, for the benefit of the local public, facts and objects connected with the life and conditions of the different parts of the British Empire. That would be a most desirable thing, not only from the point of view of the British public, but also from the point of view of the inhabitants of the various parts of the Empire.

Mr. C. J. ffoulkes, O.B.E. (Curator of the Tower Armouries) said that the lecturer's suggestion that museums should help each other by handing over certain specimens which were not of particular value to them, was one in which he was particularly interested. He was engaged in an endeavour to sort out various military exhibits in several museums under Government control some of which were absolutely unknown to the public, though they were of extraordinary interest from the historical point of view. He hoped that when these re-arrangements had been carried into effect the several military museums under Government control would be of more use to the student and more interesting to the general public. He, too, desired to emphasise the importance of labels. His experience was that the public would pass an unlabelled exhibit but would at once stop and examine a labelled exhibit. If in addition to the label a photograph of the exhibit in use, and perhaps a map of the locality in which it was used, were appended, there was no doubt about the visitor's attention being arrested. One very important point was to see that the attachment of the label was perfect. Very often a label came off, and the attendant picked it up and affixed it to the nearest object which had no label, with some resultant confusion! He desired to put in a word for the public, because he was perfectly certain that, if objects were shown in a right and attractive way, the public would be quite ready to appreciate museums.

Mr. Hargreaves Wilkinson (Public Library and Museum, Rawtenstall) thanked the lecturer for many of the hints he had given. As a member of the

Lancashire and Cheshire Federation he could speak most highly of what the distribution of duplicates had done in Lancashire and Cheshire.

THE LECTURER, in reply, said there had been little said in the way of criticism. He had been hoping that some of his suggestions would have been adversely criticised, but the audience on the whole seemed to have agreed with what he had said. He believed very much indeed that there was a real need for the evening opening of museums, but it had been the unfortunate experience of some places where museums and other institutions had been opened in the evenings that they had not been used by the public as much as had been expected. He also agreed that it was extremely important that museum committees should co-opt persons who had special interest in museum work. Professor Graham Wallas had suggested the use of reproductions. The use of reproductions was coming in more and more, and they were extraordinarily useful and serviceable in filling gaps and making the authentic objects far more interesting. With regard to Dr. Bather's friend's statement about the undesirability of moving houses from their natural surroundings and putting them into an open air museum, unfortunately the choice was between saving them for an open air museum or letting them be destroyed altogether. A great number of such houses had already been destroyed and a great number more were in the process of destruction. Sir Atul Chatterjee had drawn attention to the lack of a properly equipped Imperial Museum. There was nothing in this country to compare with the Colonial Institute at Amsterdam, where the whole of the products of the Dutch Colonies were exhibited in a most attractive building, which contained lecture rooms where colonial languages were taught, and to which anybody could go. He apologised for lack of constructive suggestions. His point generally was to urge that the museums and the public should get together, make a beginning, and lay down lines on which future progress could be made.

A vote of thanks to the lecturer having been carried unanimously the meeting terminated.

OBITUARY.

H.H. PRINCE JOHN II OF LIECHTENSTEIN.—The death, on February 11th, of John II, reigning Prince of Liechtenstein, in his 89th year, at Feldsberg Castle, brings to a close the longest reign, if we exclude periods of minority, of modern European history. The late Prince, who succeeded to the throne on November 12th, 1858, in his 19th year, belonged to an ancient family of the Austrian nobility and was the tenth of his line to rule in the small Alpine State of Liechtenstein, which was purchased, in two instalments, by Prince John Adam of Liechtenstein in 1699 and 1712. The territory had previously consisted of two fiefs of the Holy Roman Empire, the Lordship of Schellenberg and the County of Vaduz, which for several centuries were held by the Counts of Montfort.

In 1858, when the late Prince succeeded his father, Aloysius I, the Principality was a member of the German Confederation, and was obliged, under the constitution of the Confederation, to maintain a military contingent in proportion to its population. In 1866, on the outbreak of war between Austria and Prussia, the Prince naturally took the Austrian side, and was a signatory to the treaty of Peace which brought the disastrous campaign to a close. The German Confedera-

tion having been dissolved, as a result of the war, the Prince of Liechtenstein abolished military service and entered into a customs, monetary and postal union with Austria, which continued until the fall of the Austro-Hungarian Empire. The reigning Prince of Liechtenstein, however, was so strongly entrenched in the affection of his subjects, that the only change brought about by the Great War was the substitution of a Swiss for an Austrian customs and monetary union. This arrangement did not affect the sovereign status of the Prince, who continued as before, to issue his own stamps and coins. The late Prince, who was well known for his patronage of the Arts, adorned his Principality with a number of fine public buildings, while he made of the gallery of the Liechtenstein Summer Palace in Vienna one of the finest private collections of pictures in Europe. He had been a Life Fellow of the Royal Society of Arts since 1892.

CORRESPONDENCE.

THOMAS GRAY MEMORIAL TRUST.

In the *Journal* dated February 8th I am interested to note a paragraph headed " Thomas Gray Memorial Trust—Prizes for the improvement and encouragement of Navigation " ; and that the Society has been appointed residuary legatee for the purpose of founding the memorial.

Those who came in contact with the late Mr. Thomas Gray, C.B., in his official capacity as Assistant Secretary to the Board of Trade have a keen recollection of his ability with shipping matters, more especially on the question of lights and signals for the prevention of collisions at sea. The writer was at that time—some thirty-five years ago—actively engaged in assisting to codify the various signals for fishing vessels. About that time the question of steam trawlers and their various lights and signals had to be dealt with, as, under the heading of " Steamships," they were a new institution. The lights for fishing vessels became very perplexing when fishing operations were being carried on. A special light was suggested for the use of steam trawlers when towing their gear, and Mr. Gray obtained an Order in Council which made this light an official light for steam trawlers when towing their gear ; this has been adopted by all nations. It is known as the Triplex Lantern, and is carried at the masthead when the trawler is at work. The settlement of this difficulty had been troubling the authorities for some considerable time, and Mr. Thomas Gray was credited with the solving of this difficult problem.

G. L. ALWARD.

APPLICATIONS OF ELECTRICITY TO MEDICAL PRACTICE.

Mr. G. G. Blake in his very interesting lecture on the Applications of Electricity to Medical Practice, published in the *Journal* on January 18th, omitted to mention the name of the late Dr. W. Deane Butcher, Editor of the Archives of the Rontgen Ray, as a pioneer of the Therapeutic Application of X-Rays.

From the year 1901 he treated patients in the London Hospital for Skin Diseases, in Fitzroy Square, as an electro-therapeutist, and in 1905 installed the X-ray apparatus by means of which he successfully treated many cases of lupus, naevus, etc., until the year 1914.

A. DEANE BUTCHER, F.R.S.A.

EXHIBITION OF APPLIED ART.

Exhibition of Handmade Fabrics and Pots, Mansard Gallery, Tottenham Court Road.—The greater part of the fabrics on view at this show are hand spun as well as hand woven. We are confronted with an important movement towards the humanisation of industry. Certainly, the crafts cannot hope to recover all the ground lost to the machines, but in a prosperous nation in future we may expect a vastly greater proportion of individual goods to be made and sold.

The first exhibit that one notices on coming into the gallery is the work of the Skye Weavers, formerly of the Island of Harris. The solidity of the technique here is the main attraction; but the skill and regularity of the simple woven patterns must not be overlooked. Much is made, throughout the show, of the intrinsic beauty of the threads and yarns used. Some of the German as well as the British craftsmen have left their rugs and other items undyed; the grey sheep produces a wool of fine colour, and in one case the black sheep proves no less inky as to his coat than he is imagined to be in the nursery. The most interesting German rug is by Miss Ella Lettre, of Dresden.

There is no doubt that Miss Enid Marx succeeds in imparting a most artistic touch to her work, which stood out from a very high average of exhibits at the recent Arts and Crafts Exhibition at Burlington House. Miss Marx suggests wood engraving in some of her patterns, which are none the less appropriate as decorations for curtains or skirts. She sometimes uses the discharge method of dyeing with excellent effect: the material is first dyed all over and then treated by subtraction, not addition.

Visitors should compare the more colourful work of Mrs. Kennington with the monochromes of Miss Marx. Brighter again are the Assam silks of Miss Kitty Doncaster: these are hardier and coarser than our western silks. The designs of Mrs. Burder, themselves novel and attractive, would not be unsuitable for wallpaper; in fact, Mrs. Burder is preparing some wallpaper patterns, which are to be printed by the Curwen Press.

Miss Barron and Miss Larcher are now well known for the work they have done in co-operation. Among their exhibits is a fine design on muslin backed with linen. In general one is likely to be impressed by the success of the more geometrical patterns. The modern genius seems to lie here: yet how dissimilar these repetitions can be is quickly appreciated if one compares a Nash design with, say, the Hungarian rug displayed in the outer gallery. There are reminiscences in this of the Orient and the South; no such associations cling to the best English work, in which a small unitary pattern is multiplied.

Somehow, although it is true that pots may have the appeal of shape in addition to attractive texture and pattern, the ceramic part of the exhibition is less fascinating than the textile. Mr. Alfred Hopkins deserves credit for his revival of salt-glaze stonework, but more on utilitarian than æsthetic grounds. His least fanciful work is the best; he shows a very simple and admirable flower-pot, as well as a too ambitious though highly skilful vase, with some such personage as Father Thames in relief.

A curiously regular level of good work is kept by Miss Braden and Miss Pleydell-Bouverie. It shows real æsthetic sensibility, and is seldom very striking; its merits grow on one. Michael Cardew has made a speciality of galena glaze, and has compromised not without dignity between the beautiful and the useful.

P. B.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 25.. Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. R. W. Gregory, "Electric Supply to the Rural Districts of England."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture I).

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Paul Vacher, "Present Aspects of French Politics." (Lecture II).

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications." (Lecture I).

At University College, Gower Street, W.C. 2 p.m. Prof. Dr. J. G. Robertson, "The Romantic Age in Germany."

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture III).

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture VII).

TUESDAY, FEBRUARY 26.. Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. J. B. Charlesworth, "The Topoke of the Congo."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. R. A. Chattock, "The Modern Use of Pulverized Fuel in Power Stations."

At the College, Loughborough. 6.45 p.m. Mr. J. H. R. Nixon, "Motor Converters."

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. Mr. R. G. Collingwood, "Form and Content in Art."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture V).

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture III).

At King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture VII).

5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Motors to Heavy Traction." (Lecture III).

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical measurement of Light, with Biological Applications." (Lecture II).

At University College, Gower Street, W.C. 5.30 p.m. Lecture on "The Current Work of the Biometric and Eugenics Laboratories." (Lecture V).

WEDNESDAY, FEBRUARY 27.. Aeronautical Society, at the Engineers' Club, Manchester. 7 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Prof. Nichol Smith, "Warton's History of English Poetry."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. E. C. Pound, "Pile Driving Formulas and Methods of Cast-in-Situ Concrete Piling, with special reference to the 'Vibro' Concrete Piling System."

Electrical Engineers, Institution of, at the Midland Institute, Birmingham. 7 p.m. Joint Meeting with Midland Centres of the Institutions of Civil and Mechanical Engineers.

United Service Institution, Whitehall, S.W. 3 p.m. Colonel D. C. Cameron, "The Problems of Supplying Mechanised Forces in the Field."

University of London, at King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History." (Lecture VII). Mr. Bernard Rackham, "English Glass and Pottery."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture VII).

At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. J. Traill Stevenson, Demonstration of the Recordaphone.

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications." (Lecture III).

At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture VI).

5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist and Ryaberg." (Lecture I).

THURSDAY, FEBRUARY 28.. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. R. A. Frazer, "The Flutter of Aeroplane Wings."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Carpenters, Worshipful Company of, Carpenters' Hall, Throgmorton Avenue, E.C. 8 p.m. Mr. E. Guy Dawber, "The English Countryside and Cottages—Old and New."

Electrical Engineers, Institution of, Savoy Place, W.C. Mr. Ll. B. Atkinson, "How Electricity Does Things." (Faraday Lecture).

Linnean Society, Burlington House, W. 5 p.m.

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Fred Skull, "Collecting Unusual Specimens of Old Furniture."

Mechanical Engineers, Institution of, at University College, Nottingham. 6.30 p.m. Mr. H. E. Yerbury, "Corrosion of Metals and its Prevention."

At the Engineers' Club, Manchester. 7.15 p.m. Mr. J. S. G. Primrose, "Micro-Examination of Failures."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. W. A. Benton, "Metallurgy and the Evolution of the Balance."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. A. O. Rankine, "Physics in Relation to Oil Finding." (Lecture II).

University of London, at Bedford College for Women, Regents Park, N.W. 5.15 p.m. Mr. A. E. Henderson, "Byzantine Architecture."

At King's College, Strand, W.C. 5.30 p.m. "Czechoslovakia." (Lecture VII). Mr. Paul Selver, "Modern Currents in Literature."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture VI).

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture VI).

5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: A Course for Laymen." (Lecture II).

5.30 p.m. Prof. Dr. Edmund G. Gardner, "Lancelot and the Holy Grail."

FRIDAY, MARCH 1.. Chemical Industry, Society of, at Milton Hall, Manchester. 7.30 p.m. Dr. T. P. Hilditch, "Recent Advances in our Knowledge of the Structure of the more Common Fats."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. W. Lawson, "The Rotor Bearings of Electricity Meters."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. (1) Mr. S. E. Hollingworth, "The Evolution of the Eden Drainage in the South and West." (2) Mr. M. Chatterjee, "The Accessory Minerals in the Bodmin Moor Granite."

Junior Engineers, Institution of, 39, Victoria Street, S.W. 7.30 p.m. Mr. L. S. Atkinson, "Notes on the Control of Electric Lifts."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Sir Joseph Isherwood, "Do the Rules of Classification Societies tend to Improve Shipbuilding and Engineering in this Country?"

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. Sir Israel Gollancz, "Problems in the Alliterative Poems."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Robert Robertson, "Infra-Red Spectra."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture IV).

At King's College, Strand, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation."

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture VII).

5.30 p.m. Dr. J. Howard Jones, "Hygiene of the Mercantile Marine." (Lecture II).

SATURDAY, MARCH 2.. L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Prof. J. R. Ainsworth Davis, "English Food, Past and Present."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 4th, at 8 p.m. (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, "Thirty Years' Experience of Industrial Maladies (1898-1927)." (Lecture III.)

WEDNESDAY, MARCH 6th, at 8 p.m. (Ordinary Meeting.) TOM PURVIS, "Commercial Art." MR. PERCY V. BRADSHAW will preside.

FRIDAY, MARCH 8th, at 4.30 p.m. (Indian Section.) W. H. MORELAND, C.S.I., C.I.E., formerly Director of Land Records and Agriculture, United Provinces, "The Indian Peasant in History: an Introduction to the Linlithgow Report." SIR EDWARD D. MACLAGAN, K.C.S.I., K.C.I.E., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

SHAW LECTURES.

MONDAY, FEBRUARY 18th, 1929. SIR THOMAS MORRISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the first of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

TWELFTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 20th, 1929. PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., in the Chair.

A paper on "The History of the Development of Fast Dyeing and Dyes" was read by MR. JAMES MORTON, Chairman of Morton Sundour Fabrics, Ltd., and Scottish Dyes, Ltd. The paper and discussion will be published in the *Journal* on April 12th.

DOMINIONS AND COLONIES SECTION.

TUESDAY, FEBRUARY 26th, 1929. SIR WILLIAM J. LARKE, K.B.E., Director, National Federation of Iron and Steel Manufacturers, in the Chair.

A paper entitled "The South African Iron and Steel Industry: its Development and Possibilities" was read by DR. H. J. VAN DER BŸL, Chairman, South African Iron and Steel Corporation, Ltd.

The paper and discussion will be published in the *Journal* on April 19th.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

FRIDAY, DECEMBER 14TH, 1928.

DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.R.S., F.L.S., in the Chair.

THE CHAIRMAN said it was unnecessary to make any formal introduction of Lord Olivier, as his record of work in the Colonies of British Honduras, Jamaica, and in the Colonial Office, and the Ministry of Agriculture was so well known, and it would be agreed that he knew a good deal about the idiosyncrasies and mentality of agriculturists, both black and white. He had happened to look at "Who's Who," as Chairmen generally did, for some inspiration when taking the chair for a distinguished lecturer, and he noticed that Lord Olivier's recreations were put down as "the normal forms of loafing and dilettantism." He could not refrain from quoting that because this seemed to be very largely the attitude of the unsophisticated negro towards agriculture. If that were so, he felt that one of the reasons Lord Olivier was giving his paper that night was to show that there were ways and means of remedying that defect!

The following paper was then read:—

THE IMPROVEMENT OF NEGRO AGRICULTURE.

By the RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D.

Agriculture is the paramount industry of our tropical and sub-tropical colonies. Englishmen are now attempting in Africa what they undertook in the 17th century in the West Indies, namely, as planters and farmers, to establish communities maintaining a European civilisation upon a basis of negro labour. In the West Indies the labour was that of kidnapped slaves. We now repudiate slavery and, theoretically and professedly, at any rate, forced or constrained labour. Can a stably prosperous agricultural State be built up by white men in a community where the labouring population are free native Africans? The history of Jamaica yields instructive material for guidance. Jamaica (population 920,000) is the largest agricultural community in the

British West Indies. Its civilisation is European, though of its inhabitants not one in sixty is white. Recent developments in West Africa are also, no doubt, significant. The prosperity of West African agriculture has advanced remarkably on much the same lines as those which have been found most advantageous among Jamaica negroes. And social improvements accompany the economic. But pioneers of white colonisation in East and South East Africa disclaim that West African developments can have any relevance to East African* problems, which are those of what is spoken of as a " white man's country," although the people to whom it looks for its manual labour are black. It might correspondingly be propounded that the economic and social history of Jamaica has also been so different from that of East Africa that no lessons can be learnt from the one by the other. I propose to attempt to indicate that in important essentials this is not the case, but that the conditions are impressively parallel.

European agriculture is a highly developed art, greatly superior in its total efficiency to that of African negroid communities. It is superior in its primary dealing with the soil, in regard to access, fencing, drainage and tillage, for which it is far better equipped with tools and machinery. It has evolved the art of manuring, both by combining cattle-keeping with tillage and by the application of chemistry. To its earlier machinery for ploughing, cleaning, drilling, harvesting, threshing, it has more recently added mechanical traction and transport. Most European tropical planting has involved the conjunction with husbandry of manufacturing processes, again requiring machinery and the developed techniques of Europe. Formerly every sugar estate was also a factory, progressively demanding improved engineering and chemistry. The same was true of coffee, tea, tobacco, fibres and other staples ; the marketable value of which depends upon factory processes, in almost all cases best carried on in large establishments, the capitalisation of which is impossible for peasant or native cultivators. There is now, indeed, a rapidly growing tendency to divorce manufacture from cultivation. The planters' work tends to specialise on pure farming, the manufacturing to be transferred to central factories, either independently capitalised or co-operatively owned and managed on behalf of the planters. An elaborate productive system of this character, which greatly increases the yield of agricultural values in proportion to the physical labour directly employed in the field, can only be introduced and established by representatives of the civilisation which has evolved modern methods of industry. Yet the actual work on the soil which grows the community's food and the raw materials destined for manufacture must, it is recognised, remain non-European. Can the labour of native Africans be made stably efficient in their share of this exotic and complex method of wealth production ? Englishmen are familiar with, and naturally have confidence in, our English system of capitalist farmers hiring and directing wage-labourers. They inevitably start by assuming that

* The best account, known to the writer, of East African Native Agriculture is the chapter by H. L. Shantz, of the U.S. Department of Agriculture, in the Report of the Phelps Stokes Trust Commission on African Education. Smith & Sons, 1924

an efficient agriculture must needs be so conducted, and that the establishment of such a system is the best thing European civilisation can offer the African, who will find it to his advantage to earn his living by regular work at wages. But that system has its roots in an agricultural, economic and social history which is peculiar to our own island. It does not predominate even so short a distance away as the other side of either channel that bounds our shores. It has no kind of root, preparation or parallel in uncivilised Africa, where no industrial revolution has created a landless working class ; and it might appear at best somewhat sanguine to take it for granted that as a system of agriculture it is likely to prove the best in such a country, or even workable there.

African native agriculture, speaking generally, is precisely the same in its main characteristics as the agriculture of free negroes is in Jamaica or was until local missionaries and the Government began to pay attention to its improvement. The first operation of this characteristic African husbandry is to select uncleared land of suitable aspect and chance of rainfall, to cut down the trees and undergrowth and burn them upon the land. This process makes clearings generally averaging about an acre for each householder, rarely exceeding two. The soil of the forest is rich in humus-decayed leaf mould. The burning of the timber and brushwood provides a supply of potash, and destroys the insect life and weeds in the surface soil. The ground is broken up, roots are grubbed and burnt, and a garden of rich and fertile soil is provided. It is cultivated with the hoe, the cutlass or even more primitive tools, and food plants are sown and set. The East African Commission of 1924 referred in their Report rather regretfully to the " higgledy-piggledy " aspect of the native cultivation they saw. Of course, the cultivation is "higgledy-piggledy." It is made so on purpose. It is planted for a rotation. The expert cultivator sets each particular plant or kind of seed where he or she knows it will thrive best and fit in most conveniently with the general purpose. The selections and combinations are very varied. Of the vegetables and food plants and fruit trees cultivated in Africa and the West Indies some are indigenous ; in both many of the commonest are exotic. There has been a remarkable diffusion of food plants between Asia, Africa and America. Yams of all sorts, sweet potatoes, gourds, beans and other legumes, spinach and salads, maize, millet, cassava, ground nuts, plantains, bananas, ochroes, akees, peppers, scallions, sugar-cane, coffee, tobacco, oranges, limes, these and other plants adapted to this kind of cultivation have been distributed in a profuse variety all round the world according to the character of the soils and climates. And traditional arts of growing them have been developed, whether the particular operations are discharged by women or men, or divided between them.

What the West Indian negro calls " bread-kind " (tubers producing starch foods), have to stand in some cases two years before they mature. Cassava stands three or longer. In between and round about the hills or ridges made for the tubers the quicker growing plants are put in and harvested successively

as they mature. Plantains and bananas may be set around the plot or here and there about it, so as not to shade the earlier crops too much. If the cultivator intends permanent occupation he will also plant coffee, kola, annatto or other shrubs to bring in food or money, when the vegetables have been reaped. But African agriculture of this type does not contemplate permanent occupation. Animal manure is not used, except by some more advanced African tribes.

This art of food cultivation is, for its purposes, highly efficient. On a well-chosen and well-handled plot the quantity of food produced is astonishing and the yield is continuous. In Jamaica especially, where the method has been intelligently developed and improved, good peasant cultivation of this mixed character yields annual values running frequently up to £40 an acre. But the method exhausts the land and the plot has to be shifted. A nomad habit is maintained in the population. Spent land must be abandoned to rest, as our own ancestors fallowed theirs before rotation husbandry was invented. But fallows in tropical countries cannot be pastured by cattle, because the acres are not continuous, and an open-field system cannot be practised, whilst weeds and coarse vegetation spring up more quickly than any sort of grass that will feed stock. When the yield no longer repays the labour the plot is allowed to grow up in bush. After a period of years the new jungle is again cut down and fired ; the seeds of the weeds in the soil burnt up and the insect life destroyed. Cultivation is reinstated and proceeds as before. What the African husbandman likes best is virgin woodland. The accumulated fertility repays the heavy labour of clearing. The forest is ruined, to the grief of the lover of timber. After the land has been cleared once or more, it frequently happens that, by the time the cultivators has done with it, exposure to weather has caused a good deal of the soil to be washed away. This is one of the wasteful effects. The destruction of the forest diminishes the capacity of the soil to retain moisture and feed the springs ; after repeated clearances the tropical rains wash out and carry away the humus, the soil becomes more and more barren, where it is shallow it is washed off bodily from the rock, or the hard raw subsoil is left exposed. Such "ruinate" land is a frequent eye-sore both in Africa and wherever the negro has practised this traditional husbandry. It is, in fact, a rational and efficient art of agriculture, so long as there is abundance of land to be used. To Europeans, who have so long had no land to waste, who have long ceased their migrations and have had to devise a system of static husbandry and renew their soil by manuring, native African agriculture is exasperating.

This traditional agriculture was imported into the West Indies by negro slaves, and so far as negroes either free or by sufferance had access there to land for their own purposes, this was the system they there pursued.

Jamaica in slavery-time had a well-developed system of arable and pastoral agriculture, carried on with an intelligence quite up to the standard of their times by English planters. In their generation they were as wise and as enterprising as new British settlers in Africa are in our own. Their sugar estates

lay in the plains around the shores of the island, or where suitable lands could be found in the valleys and uplands. They built and furnished fine homes and factories of good masonry suitable for their time, though too small for modern economy.

The coffee estates were among the mountains, very largely on the white limestone formation which covers three-fifths of the island. These planters also were able and spirited. Beckford's house at Fonthill in Jamaica has ruins as ambitious, proportionally, as those of his Wiltshire Folly.

Large areas of the island remained in forest. These lands were private property, but only used by their owners for timber and fuel supply for the sugar works. Most estates had their "mountain" for this purpose. In these "mountains" worn-out slaves, or freed negroes renting plots, were allowed to grow provisions. They practised their traditional African agriculture in methods indistinguishable from those used in West Africa to this day. This agriculture was not so highly developed as is that of some agricultural tribes in East and Central Africa. The West African and his West Indian descendant were not corn growers or field agriculturists. Nor had they cattle, and though Jamaica is so excellent a cattle country, cattle, whether for milk or manure, remained entirely unused by the negro squatters. Fortunately, most of the upland country has a porous chalky subsoil which retains moisture, and when land has been cleared for fuel or negro grounds, secondary forest and bush quickly reclothed it, which was not the case on the deeper and heavier soils.

Jamaica was settled with the intention that it should be a "white man's country." All the desirable land was granted out by the Crown in large "patents" of 2,000 acres or more to English settlers. Laborious Dutchmen were imported from Surinam to start sugar planting, as Africander farmers were introduced into Kenya. The lands were patented on a nominal quit rent of ½d. an acre. The unalienated lands, not of large extent, were remote and inaccessible. There was practically no land left for negroes to own, nor was there in early days any demand for it, for most of the negroes were slaves.

After emancipation the sugar and coffee estates declined. In the uplands many went out of hand entirely or were carried on with the least possible labour, as cattle, pimento, and logwood "pens." The negro quarters on the old sugar estates were miserable hovels. Their sites are marked to-day by the fruit trees that were planted about them; but the negro's favourite foodstuffs yams and other "bread kind," could not be grown there. They needed woodland soil and the African mode of culture. Some upland estates were bought by missionaries, chiefly Moravian. They built churches and schools and established villages of negro small-holders whom they helped in their agriculture and taught and encouraged to add to it, to grow coffee and other saleable crops and boil sugar for island markets. It was missionary effort of this kind that laid the foundations of improved negro peasant production and civilised life. On the estates which survived, the freed negroes remained very poor, very ill-

paid, very squalid and in no way progressive, at any rate so far as any influences of the estate system affected them. Partly, no doubt, owing to the traditions of slavery, estate work remained unimproving to them. Contact with it exercised no civilising or educational influence. The labourers were as lazy as they could be. No proprietor that could keep his estate going would sell land to negroes. The difficulty of obtaining plantation labour increased. In some of the smaller West Indian islands, where there was much unoccupied land, estates became more and more unworkable. The cultivation of sugar estates in Demerara, Trinidad and St. Lucia and parts of Jamaica was only maintained by importing indentured Indian labour. Some districts of Jamaica through special conditions managed to carry on without this, but the negroes there were poorest.

The Royal Commissioners who visited Jamaica in 1883 print a statement by the Rev. Josiah Cork, an Anglican clergyman, whose curacy began about the time of the abolition of slavery and who was one of those who endeavoured, by the provision of land and advice, to improve the conditions of the ex-slaves and free cultivators. He recalls that immediately after emancipation high rents were almost universally imposed by estate proprietors on the huts and provision grounds of the negroes upon their properties, and the wages of hired labour were reduced by one-half. The result was a hasty stampede from the estates of multitudes of labourers to purchase small freeholds, for which, when they were to be had, high prices were asked. On freeholds thus acquired, generally outlying (for the stronger estates would not sell) and with well-timbered lands, clearings were made for African agriculture, remote from the white men's estates.

It was to these out-lying lands that food growing was almost wholly transferred, for during the apprenticeship period which followed slavery the labourers had been for the most part confined to the land they had cultivated on the estates mountains, and had well-nigh exhausted it by 1838, when apprenticeship ceased. Only those, however, who had some command of means could acquire freeholds; the less provident, renting squatters or merely trespassers, had still to labour for hire and could only partially raise their food, or left food-growing to their families, while they worked for wages to earn money to buy land. Taxation was made heavy upon the small freeholders; the smaller the freehold, the higher the rate of the tax. The natural result was a growing discontent, which only the great fertility of the newly-occupied lands for a while partly stifled. (It will be observed that these conditions were essentially similar to those now regarded as necessary for the development of "white men's countries" in Africa, namely, restriction and segregation of negro landowning, the levying of high rents and high hut taxes, and pressure on the men to work on estates, leaving the burden of food-growing on the family). The apprenticeship system, which failed, had been designed philanthropically both to maintain the estates' cultivation and the civilisation of

the negroes by "contact." The resulting discontent rendered necessary some reform of the fiscal system and the burden of taxation was in some measure transferred from direct to indirect duties, of customs and excise, which, so far as food was concerned, did not press heavily on the negroes, who grew most of their own. And this, Mr. Cork remarks, must have happened years earlier had not the quantity of outlying woodlands been so great, a high rent being gladly paid for fresh food-growing lands, unaccompanied by the obnoxious direct property tax. As these lands became in many parts fully occupied, the natural result of wasteful culture ensued, the profit gradually came down to and fell below the rent. The fertility of the available lands being exhausted, the negro cultivators, left without guidance towards the improvement of their cultivation, so as to make continuous cropping possible, looked desperately towards the large reserved estates of the white landowners, and their increasing distress conduced largely to the Jamaica "Rebellion" of 1865.

This process is now repeating itself in South Africa in those parts in which white land monopoly has been established, and the improvement of native agriculture neglected. It will inevitably repeat itself in Rhodesia and Kenya, unless the policy of developing native agriculture and encouraging the production of crops that will yield the natives money is resolutely pursued. The essential superiority of estate cultivation and the European system of farming over the native African system of food-growing is that they are continuous, and put back into the soil year by year what they take out. Hence, unquestionably, in the West Indies, the sugar industry with its large productivity was of indispensable value, and so long as negro cultivation was left to take care of itself, the argument that the estates must be maintained, even at the cost of putting pressure upon the negroes to work on them, had some ostensible cogency.

> "The Commissioners," Mr. Cork wrote, "have only to examine for themselves to ascertain the fact that native food is far from being in abundance in the markets; the growers generally travel far from their homes to grow it and carry it far to sell it, the country the while being wholly deforested to meet the demand for food growth. This growth ought to suffice to make imported food in flour and other vegetables, and drinkables too, luxuries only, and to be bought as such by sale of the cultivator's surplus."

Forty to fifty years ago, then, the position in Jamaica was this. With a numerous and prolific population the larger sugar estates were being worked with imported labour; many properties were being maintained with a minimum of labour as "pens." Most of the island still was owned in large private estates thus handled, or in some cases rented to negroes cultivating in African fashion. In some districts where soil and climate were suitable and missionaries and education had done their work, there were many fairly prosperous and civilised "small settlers," intelligent black people of valuable character, growing coffee and other saleable produce, keeping ponies, mules, asses and some small

stock, but in other respects pursuing a system of agriculture still primitive and inefficient. There was a good deal of broken country from which the owners had disappeared and on which there were squatters living in wretched hovels and cultivating unprofitably and wastefully. The industry of the renters on estates which let land was of similar character. The cultivation of labourers resident on estates was superficial and worthless. There were some remote Crown lands still in thick forest, similarly squatted and trespassed upon. The Government was constantly being solicited to sell new lands to negroes outside the already partially settled districts. They were not unreasonably reluctant to do this, for " fire stick " cultivation had already destroyed much of the country, and operated to draw population further and further away from the centres of civilisation. Meanwhile the native food supply remained continually in danger of falling short.

After the " Jamaica Rebellion " Crown Government replaced the elected assembly which had represented the white landowning and planting oligarchy. The new legislature consisted at first entirely of officials and Government nominees. Nine elected members were introduced in 1883, the majority remaining official and nominated. In 1895 the elected membership was increased to fourteen, one for each parish. The elected members had the power to decide any question unless the Government declared its decision adversely to their vote to be of paramount public importance. The electoral qualification, for either men or women, is now occupancy as owner or tenant of house or land paying in local or island taxes not less than 10s. a year. The constitution has thus been progressively rendered almost completely democratic and the majority of the electors are peasant proprietors. The present Lord Irwin and Mr. Ormsby-Gore, who visited Jamaica in 1923, reported that this constitution has worked very healthily for the island, and recommended its still further liberalisation.

I recall this political history because it has done a good deal to influence the wholesome development of land policy and agricultural policy in the island during the last thirty years. Sir John Peter Grant, the first Crown Colony Governor, set up a " Survey of Lands " Department. All lands of which the ownership and title were not at that time apparent were progressively classified, their histories and titles inquired into and surveys made, and in cases where the lands were unclaimed or in illegal adverse possession, possession taken on behalf of the Crown. Many properties all over the island were in the occupancy of squatters, and on very extensive tracts the Crown quit rents had not been paid for years. Under successive laws the Government was made Trustee of all lands in the occupation of persons having no ostensible title.

If legal owners appeared they could recover the lands upon payment of the expenses incurred by the Government, and arrears of quit rent, but after seven

years notice the Government had the power to sell. Many thousands of acres were thus recovered from squatters. Much land has been restored to its legal owners, much has been sold after the expiry of the seven years' trusteeship, the remainder is still in the hands of the Government, some of it rented to tenants or exploited by the Crown Lands Department by licenses for timber and firewood.

Under the laws enabling the forfeit of lands for non-payment of quit rents the titles to more than a million acres have been investigated, the areas and boundaries ascertained and the lands advertised as forfeitable. Of this about 275,000 acres have been actually resumed by the Crown; the quit rents on much of the rest have been paid, and much remains in process of forfeiture.

By this process of resumption of title to lands originally granted out in large estates with a view to "development," but left in neglect and withheld from legitimate use by the negroes, the Government was put in a position to deal with the land of the island in the interests of the whole community. The Governor who did most in this direction was the late Sir Henry Blake. Blake did two great things for Jamaica. Contrary to the prevailing view of the island's interests entertained by the planting community, he instituted an active policy of encouraging the creation of peasant properties on the recovered Crown Lands. And he founded the Royal Jamaica Agricultural Society.

His scheme for the sale of Crown land to small settlers was brought into operation in 1895. Not less than five acres nor more than fifty might be sold to any one person. The average price was £1 an acre. A deposit of one-fifth of the purchase money had to be made by the applicant, after which the land was surveyed and the applicant put in possession, the remaining four-fifths of the purchase money, together with £2 for the cost of survey, being payable in ten years by equal yearly instalments. If within ten years the purchaser had brought one-fifth into bearing in permanent crops, he was released from the payment of one-fifth of the purchase money or received a refund. The demand was immediate and has remained constant, and many thousands of small properties have been established by means of it.

The philosophy of improving agriculture through Government aid in tropical colonies has been progressive. In Jamaica it began, as it has done elsewhere, with the establishment of a Government Botanic Department, the principal purpose of which was to introduce, test, and naturalise exotic economic plants. It was only after the recommendations of the West Indian Royal Commission of 1927 that these institutions began to be broadened into Government Departments of Agriculture. That Commission's report resulted in the establishment of the Imperial West Indian Department of Agriculture, and the latest important offspring of the same stimulus is the Imperial College of Tropical Agriculture in Trinidad. The Department of Public Gardens and Plantations in Jamaica, founded by Sir J. P. Grant, had attempted the cultivation of cinchona and tea, and under Sir Henry Blake established groves of oranges and grape-fruit experimentally in the Blue Mountains. These direct undertakings failed, but

the Department had liberally and usefully distributed seeds and seedlings of economic plants and trees. Its operations were still essentially based on the aim of helping white planters with estate cultivation. The Jamaica Agricultural Department which grew out of it progressively enlarged its scope and activities, establishing a scientific staff, including chemists, entomologists and microbiologists, to which there have been latterly added inspectors of plant diseases. This Government Department also maintains successfully two stock farms and an agricultural school. The Jamaica Government first began to pay some attention to negro production by appointing a travelling instructor attached to the Public Gardens. But his visits, which were intended to give advice in the pruning and curing of cocoa, coffee and other exportable produce, were regarded by the peasantry with suspicion. They judged that they were really made for the purpose of spying out any prosperity they might attain to, with a view to increasing their taxes. The prodigious increase of banana growing, which was built up on peasant production, being an African crop, then completely despised by the planters, but which had, in fact, been the means of saving the island from such disastrous depression as resulted elsewhere from the collapse of the sugar industry, had greatly increased their prosperity, and peasant property and small settler's agriculture were looking up and becoming recognised as of public value. But there was a tax on cultivated land as distinct from waste land, and, trivial as its incidence was, it maintained a preference for a method of husbandry that could not be identified as cultivation. The problem of improving negro agriculture was never really tackled until the Jamaica Agricultural Society, ostensibly detached from the Government, was established.

The Society was founded, almost simultaneously with the Crown Lands Settlement Scheme, in 1895. The Legislature granted £1,000 towards its expenses of organisation. Special Committees were appointed to investigate the position of each agricultural industry, what could be done to improve the quality of agricultural produce, whether its variety could be increased and new industries developed, the markets available, and whether better means of handling and shipping products could be suggested. Full reports were made on these subjects. The establishment of a Government Stock farm was recommended. It opened its public work on much the same lines as those followed by the great Agricultural Societies in this country, holding large and expensively organised shows either for the whole of the island or for the principal convenient divisions; and the favoured exhibits were cattle and horse-kind and representative products of the large estate cultivation. But the purposes of the Society and the aims of those who most devotedly worked for it were much further-reaching. They were addressed to transforming the African agriculture of the peasantry into an intelligent and scientific system of profitable production. For this purpose it was vital to get into touch with the "small settlers," the backbone of the negro population, who were actually at the time (owing to the development of the banana trade) producing the bulk of the exports. It was

essential to get these people to understand the Society's aims, to show them what it was doing, what it proposed to do, and what it could do with the co-operation of the community, and generally to try and arouse an earnest interest in and enthusiasm for improved agriculture. But these men deeply suspected the Government, associating it (as African natives have even more reason to do to-day) principally with the imposition and collection of taxes. This gulf had to be bridged. The Board of Management being mainly elected to represent all agricultural classes, and free to criticise the Government, to press agricultural needs and reforms upon its attention, to inquire sympathetically into the grievances and needs of small settlers and to make due representations if these were found reasonable, was an institution well constituted to mitigate this suspicious aloofness. This missionary enterprise involved protracted and energetic effort on the part of the leaders of the Society, its successive Secretaries and their staff. Their work encountered obstinate conservatism, indifference, easy-going insouciance and self-confident ignorance in both the principal agricultural classes, and at best a good-humoured tolerance, grumbles that the Society was a waste of public money and a confident belief that the effort would soon collapse.

In 1897, however, the Legislature was induced to increase its grant to £4,000, and the Society began to publish a monthly journal, which has appeared ever since without intermission ; except when the printing office collapsed in the earthquake of 1907.

The establishment of local Branch Societies had been intended, but did not at first make much progress. One travelling instructor was employed, detached from the Department of Public Gardens and Plantations, and an instructor in bee-keeping. The Society took steps to promote and extend the manufacture of Jippa-Jappa (Jamaica Panama) hats, a strictly local industry, by distributing the fibre plant in suitable districts and by holding classes

The Branch Societies slowly grew ; they began to invite the presence of the travelling instructor at their Meetings and for visits to members' holdings. Two, and then three, part-time instructors were added. More and more instructors to be assigned to particular districts had to be found, and worked on full time. The Secretary of the Society, who visited each district regularly, was the link between the Instructors and the Managing Board.

The Journal became popular, articles in it were read and discussed at meetings Reports at Branch meetings began to appear in the newspapers Correspondence with the Central Office increased steadily.

	Direct Members	Branches	Branch Members	Agricultural Instructors
In 1897 there were ...	364	6 with	300	1
,, 1910 ,, ,, ...	500	63 ,,	3,300	11
,, 1923 ,, ,, ...	571	267 ,,	7,621	16

The work of the instructors is the Society's most influential function. They attend all Meetings of Branches, report to the office the attendance and the subjects discussed, give addresses on technical topics of current importance and generally deal with local agricultural matters. They take interest in the work of Agricultural Loan Banks and help to establish them. They are not allowed to act on Bank Committees, but give advice and help where these have not able local assistance already. Nearly all the Local Loan Banks have been established through the Branch Societies, but are run as distinct bodies. The work of the Instructors is governed by the Society's Instructors' Committee which meets every month. Each Instructor submits a proposed itinerary of his work for each day in full detail of time and place, so that the travelling Supervisor of Instructors may be able to appear there without special notice, and go through the work of the day or the week with him. Each month the Instructors send in a detailed report of their work and a general report on the cultural interests of their district and the state of the crops. These reports are submitted to the Instructors' Committee with analyses and remarks by the Secretary.

The instructors in the course of their work give constant demonstrations on the people's own grounds on pruning and spraying, advice on the suppression of insect pests and treatment of plant diseases and on suitable methods of cultivation generally. They carry out many local experiments for the improvement of holdings in connection with local prize competitions. They are constantly on the watch to detect diseases and insect pests. Any symptoms of the most important diseases are immediately reported to the Secretary and to the Director of Agriculture, whose inspectors are despatched to attend to them.

During the earlier years of this work the general public did not see very striking results—they had to be looked for on the peasants' own lands—but a great development was going on quietly. The value of the organisation and work was extremely appreciable after the hurricane of 1903 and again during the great drought of 1907 and even more after the hurricane of 1912, when seeds and plants were quickly and systematically distributed through the Branch Societies and admirable restorative work done by the agricultural instructors by holding-to-holding visits. The scope of the Society and the numbers of its branches were on each of these occasions quickly extended. The hurricane of 1912 gave an impetus to the formation of Loan Banks. After that of 1903 the Government had begun to make direct loans to the peasantry to reinstate their permanent crops. The demand for the formation of branches and for the appointment of instructors outran the funds available. Branch Societies increasingly sent representatives to the General Meeting; until it was decided that the business required two half-yearly General Meetings; and recently there has been a demand for a two-days' meeting half-yearly.

The instructors are very carefully chosen after tests of their qualifications both in the field and by written examination and receive some business training

in the Society's office. There is plenty of competition for these posts, largely among the class of men who would make successful schoolmasters, loving agriculture and good friends with their people. Considerable versatility, knowledge and tact are required. They have shown themselves a very public-spirited body of men and on special emergencies caused by hurricanes or outbreaks of plant disease have worked most valuably.

The Branch Societies are debarred from political discussion or action, but proposals affecting the public administration of agricultural interests are discussed and debated locally, examined and criticised at the Board, and approved representations made to the Government or the Director of Agriculture.

Experience has shown that one of the most effectual means for increasing effort and production among the small cultivators is competition for prizes for holdings. Competitions are held in rotation in groups of four parishes in yearly succession, and timely preparations for them are made with the help and advice of local instructors. Marks are given on a classified scheme of purposes to be aimed at: the house, the garden, fencing, stock, poultry, provision-ground cultivation, drainage and water storage, coffee and other permanent cash-yielding crops, manuring, mulching, tillage, the pruning and care of fruit trees. These competitions have proved so popular and so convincing in results that in addition to the regular scheme, small local food-growing competitions, principally for yams, corn, and cassava, have been organised by Branches subscribing their own prize money, with occasional help from neighbouring proprietors. During the War the Society's organisation enabled great special efforts in food-growing drives to be organised. In the yam-growing competitions it is required that plantains, bananas, coffee and orange trees be planted through the yams, thus securing the establishment of permanent crops. These competitions are always carried out on old lands, some of them previously almost derelict, and the effects of cultivation, manure, and bush mulching in securing good crops from such lands, and through periods of protracted drought, have been remarkable. The established example spreads to the non-competitors.

Agricultural Shows, always popular and attractive, are now organised by the Branches themselves. The Society supplies tents on hire, receptacles for exhibits and instructors to judge and help in arrangements. The Secretary attends all Shows. In addition to live stock and riding and driving competitions all manner of agricultural produce is entered, local handicraft of all sorts, women's home industries, hat weaving, laundry and needlework.

The Society and the island owe much to public-spirited men of all classes who have continuously taken a leading part in its work, and especially to the peculiar qualifications and unflagging energy and enthusiasm of its two successive Secretaries. The democratic character of its organisation and the contact which it has established between the planting and pen-keeping class

whose members act on the Board and in many Branches, and the peasant agriculture for the improvement of which they have heartily worked, have been most valuable to the social atmosphere of the island. In regard to control of plant diseases and the maintenance of the quality of the island's stables, the interests of the two classes are plainly identical. Moreover, in Jamaica, more and more, there is ceasing to be the former line of distinction between the two main classes of cultivators, for out of the small settlers' agriculture there has arisen a gradation of planting enterprises of all dimensions between the normal £40 holding of the small settler, and the 2,000 acre estate of the planter or pen-keeper.

There are now in Jamaica 151,000 taxed holdings of land exceeding ¼ acre. Of these about 115,000 are of £40 value or less, 22,000 between £40 and £100, 13,000 more, not exceeding £1,000, and 1,400 exceeding £1,000.

There is much parallelism between the Jamaica conditions and policy in regard to land and labour which I have reviewed, and those now in play in East Africa, where immigrants are setting up a community dependent chiefly on agriculture, with a white employing class and negro labourers. In both it is axiomatic that the organised cultural art and practice of Europeans are necessary for the maintenance of the essentials of white civilisation. In both there is a populace of African cultivators, dependent for their food supply upon an incomplete agriculture carried on in an unstable and in some respects wasteful fashion. Although the condition of the peasantry of Jamaica has been much modified and improved, the progress has been from a condition of things which two generations ago appeared to many people quite as unpromising, notwithstanding previous centuries of white civilisation, as they may appear in Kenya to-day. For purposes of comparison I speak of Kenya especially, because the ambition of European settlement there is to make it a community of a character as different from West Africa as are the British West Indies. Elsewhere in Africa there is being attempted a policy of building up a civilisation based on the native life. There was never any notion of that in the West Indies, and it is not the policy in Kenya to-day: at any rate, so far as concerns that portion of the extensive area so-called, which forms the highland enclave deemed suitable for permanent white habitation. Jamaica, it might appear, had advantages which made negro progress there easier. It had. but the significant thing is that they had accomplished so little. The institutions of State were English in character. the language was English: Christianity was diffused elementary school education, though long withheld, and still very deficient, was widely available. The estates had for generations been worked on a system of agriculture founded on European practice, well adapted to local conditions. Negroes had been trained for generations upon these estates. The black population was plentiful. The maintenance of estate cultivation was regarded as the first necessity of the State. The acquisition and occupation of land by negroes had been discouraged and restricted as much as possible,

not only on the plea of economic advantage but on the argument that work on estates and contact with the employing class was an educative influence and that the negroes became barbarised (which was true) if they got away into the backwoods far from markets, churches and schools. The fiscal system had been trimmed to subserve this policy ; never, indeed, with such frank directness as it is in our new African Colonies, because British sentiment with regard to dealings with negroes still at that period remained liberal, and paid respect to the principles which had decreed the abolition of slavery. Nevertheless, as now in Africa, the taxes on the negroes' huts were excessive, the taxes on their holdings were burdensome out of all proportion to those on larger properties. Heavy import duties were levied upon such merchandise as they were likely to wish to buy, in order to encourage them to work for more money to buy them. Notwithstanding this pressure and the abundance of population, the planters suffered from lack of labour supply and clamoured for Indian immigrants, while outside the estates there persisted and slowly extended the African system of agriculture. Some proprietors abandoned their cultivation and rented land to squatters. Others allowed grounds rent-free to tenants who would give them labour as wages. The complaint was not so much that the labour was inefficient as that it was intermittent and unreliable. Except in such an island as Barbados, where there is complete white land monopoly, this must generally be the case in a mixed community : for the normal man, whether black or white, prefers to be his own master and to use his own time and industry as it suits him best. The estates' wages were very low—9d. and 1/- a day—and if the negro had had to depend upon them for buying his food, he must have starved. The food supply for the most part necessarily depended upon the peasant agriculture. The negro householder had perforce to devote part of his time to his food cultivation. Growing crops for sale as well he had to attend to these in their season and to harvest and market them. His bananas he had to cut and carry down to the wharf on the same days as his banana-growing employer. The existence of a negro system of agriculture must needs cause uncertainty of labour supply to a concurrent European estate system. This is recognised in Kenya to-day, and sufficient taxation has been imposed on the natives there to induce them to make labour contracts of periods from one to six months. This no Jamaica negro would ever do, regarding it as a renewal of slavery. These contracts can only be enforced in Africa by rigorous masters' and servants' laws, for the application of which, by the aid of the police, a system of registration and thumb-print indentification of labourers has been imposed on the natives of Kenya, greatly to their dissatisfaction. The feeling of the negro about such contracts, whether in the West Indies or in East Africa, is simple and logical. He says : "I am willing to sell you my labour when, although the wages are small, it is worth my while to take them, for so long as I want to earn them. If after I have worked three days I stop my work, you stop my wages : we are neither of us the worse :

we have made a fair exchange." The notion of binding himself to continue to sell his work after he has ceased to want the wages, appears to him ridiculous, and except under pressure he will not do it. And he resents the pressure. Obviously, however, that kind of labour supply makes systematic farming impossible.

The renting of land to squatters and the employment of labour tenants on an estate have always been found in the long run undesirable. South African native policy is increasingly set on getting rid of squatter tenure, either by assigning land for purchase by natives or, if the more liberal ideas are followed, by encouraging permanent leasehold tenure. The temporary labour tenant proves equally unsatisfactory. His holding not being his own, he will not build a substantial house: he will not establish permanent cultivation of saleable produce: he exhausts one garden plot and shifts to another. Leaving his wife in her village at home, he takes a new consort on the estate and disseminates bastardy or disease. Either the squatter or labour tenant cannot keep stock or, if he does so, they invariably become a nuisance to the estate proprietor. He and his household become a nest of thieves. They steal from the estates, and, having themselves no interest in permanent cultivation, they steal from one another and from their neighbours who have.

The Government of Jamaica began its attempts to improve the African peasant agriculture of the island by direct methods: setting up demonstration plots, sending Kew-trained gardeners to lecture, distributing pamphlets. Such measures were as ineffectual as the like have been when attempted by the Board of Agriculture in this country for the improvement of British farming. The contempt of the negro planter for all this kind of "buckra foolishness" was hardly less complete than is that of the British farmer for Whitehall agriculture. It is a mistake to suppose that British-trained agriculturists can see at a glance what is wrong and what is right with African methods, the product of long traditional experience. Instructors had to be found who did not appear as officers of the State or agents of the employing class, but were men who understood and sympathised with the lives of the people and loved to work with them. They proceeded experimentally, not on Government demonstration plots, which to the negroes meant nothing, but by inducing them on their own grounds to try methods of improving things good and useful for themselves. They improved tillage by substituting the digging fork for the hoe, and showing how to use it.

The report of the Supervisor of Instructors on holdings entered for competition in the parish of Manchester for 1927-28 bears witness to the results attained in the development of the art of negro agriculture without shifting of ground:—

"This is the seventh Prize Holdings Competition held in this Parish since the inauguration of this very valuable work by the Jamaica Agricultural Society

and while some of the former competitions have been carried through under difficulties, there has never been anything to compare with the present instance. Heavy and continuous rains prevailed throughout September and October, then suddenly ceased; from November, 1927 to July, 1928, hot sun and hot dry winds persisted day after day, until the earth became parched, and the usual agricultural operations became impossible, and the water supply for both man and beast was practically exhausted, making it necessary to spend much valuable time in going from district to district in search of water. However, in spite of these great difficulties the competitors persisted in their efforts to protect their crops and stock against the effects of the drought, and to get the holdings ready for the competition.

"While, of course, the holdings could not fail to show the ill-effects of the long drought, they certainly showed still more prominently the good effects of care and cultivation. To see the way in which some of the competitors have brought their crops through a drought of nearly ten months' duration was gratifying beyond measure. As I have already mentioned, the task of judging these holdings was not made more pleasant by the hot, dry winds and scorching sun, but at the same time they did but render the contrast afforded by the beautifully cultivated citrus and coffee groves more refreshing. While the majority of people in the parish were getting desperately short of water it was most pleasing to see some competitors who could point with pride to stores of beautifully clear fresh water, and there is no doubt that the peasantry generally are making great improvements in the provision of this first essential of life, thanks to the help available from the parochial funds at the instigation of the Jamaica Agricultural Society. Great improvements are also observable in the housing and general surroundings of the competitors. Thirty-eight were awarded full marks for the condition of their house, and the sanitary conditions also show a very marked improvement, and it is only fair to mention here that the Jamaica Agricultural Society was the first body to methodically urge improvement on these lines. The general condition of the stock throughout the whole competition showed most marked improvement; I do not think I saw one tick.

"Manchester, together with some of the other parishes and sections of parishes, was noted even from the early days of the competition for the very neat and tidy holdings, and in some instances the well-kept staple crops, particularly coffee, pimento and citrus. But beyond a certain point there was a kind of stagnation, a want of life, energy and interest and the lack of a desire for further development; and particularly any decided or systematic effort to combat the effect of drought and other climatic difficulties. After following with keen interest the influence of these competitions, and the detailed work of the instructors over a long number of years, and comparing the conditions that exist to-day with the past, say, 15 or 20 years ago, one is greatly impressed with the changes which have been brought about. The holdings of the present day which have come under the above influence are full of life and interest, and are alert to receive advice and suggestions for development of all kinds. The keeping of stock on the holdings has vastly increased and the use that is now made of these for maintaining the fertility of the soil has made great changes. The introduction of heavy "bush" mulching has made possible the growing of splendid crops of yams and other foodstuffs, as well as excellent bananas for export on land which in the past would have been considered impossible. The introduction of improved methods of cultivation, the knowledge of how

to treat pests and diseases, and how to fight the evil effects of a drought, etc., have created a new interest and given a wider outlook on life, and it is impossible at the present time to go into an up-to-date holding without feeling the change. The manner in which so many of the holdings have come through the recent prolonged and severe drought should be an eloquent testimony to the value of these changes."

I feel no doubt whatever that similar methods can be applied to native African agriculture with much of the same results as have been obtained in Jamaica. It is a slow process, but it progresses and does not go back. It is thirty years since it was taken in hand in Jamaica and it might appear to a visitor, who did not know what the conditions were before, that nothing very magnificent has been done. But the work done is truly substantial and the younger generation will profit by it more rapidly.

One great help in Jamaica has been that the banana, like coffee, became a money crop common to both estates and small-holders. Bananas were long solely a negro's crop. The estates ignored it. Its arable cultivation was first methodically taken up by an American schooner captain and later by a Scotch Government Medical Officer on abandoned sugar estates. Its tillage, drainage, manuring, pruning, etc., were developed by such innovators and the improved methods have reacted on the peasants' cultivation. In connection with such crops of his own the negro cultivator is ready to profit by the methods of Europeans, and those of his class who go out to work on estates know their work when they come to it and practise it as an art, as they will not practise agricultural tasks which they have mechanically discharged as operations for their employer's profit. A growing population of negro peasant proprietors continually produces young men who want work as estate labourers. The more the agriculture which is indispensable to the mass of the people and which cannot be superseded by large estate work is improved and developed, the better becomes the service available, at fair rates of wages, from the labourers who seek work, and the better their understanding of the needs of estate employers and of the fairness of their demand for continuous and reliable service.

DISCUSSION.

The Chairman said the address had been a very interesting and able one, all the more so because the lecturer could speak with such first-hand knowledge on the subject. It was interesting to mark the point made by the African Commission about negro agricultural methods being higgledy-piggledy. When he himself went to West Africa some years ago the same thing struck him on looking at things rather superficially, but then looking into the matter more deeply he realised that, after all, the West African negro, like the West Indian, had been carrying on that form of agricultural work for 2,000 years or more, and it was the business of scientific people not to condemn off-hand what was being done as higgledy-piggledy and as being all wrong; nor was it wise to try to make the natives adopt European methods which might be quite unsuitable for the country;

it was rather the business of those interested to try and discover what were the underlying principles of what the negro was doing in his agricultural work and what was suitable to the conditions of the country, and to help the negro to improve them. He was hopeful that now the new Colonial Office scholars were taking up their agricultural appointments throughout the Tropics they would go out, after their training in Trinidad, with their eyes open as to the possibilities of native methods of cultivation. He hoped that by carefully studying Native methods they would learn a great deal which would help to build up a proper science of tropical agriculture in directions where it was so very much needed. One point worth referring to with regard to the natives of West Africa and the West Indies, in contrast to those in East Africa, was that there was a difference in the habits of the two peoples. The West Africans and West Indians were fruit-eating people, and the East African grain-eating, and that had a great deal to do with their different habits of life, and he thought made some of the problems in East Africa rather more difficult than perhaps they had been in West Africa and Jamaica. There were one or two members of the audience present who knew a good deal about negro work, and he should be glad if they would join in the discussion.

MR. W. McGREGOR ROSS said with regard to the growth of native agriculture in the West Indies, he should like to ask whether it was the case that the native cultivators were liable to interruption in their agricultural pursuits by any form of *corvée* or compulsory unpaid service.

LORD OLIVIER said that there was nothing of that kind in the West Indies In British Honduras there were customary village services.

MR. HAROLD POOLEY, Director, British Empire Producers' Organisation, desired to add one word to what the lecturer had said in regard to the Jamaica Agricultural Society, as he had had some opportunity, when he visited the West Indies last year on behalf of the British Empire Producers' Organisation, of seeing its work on the spot, and also of comparing its activities with similar bodies in other parts of the Empire, and he should like very strongly to endorse everything the lecturer had said in his paper. The Jamaica Agricultural Society was doing unique work, and it might very well be taken as the model for similar activities in other parts of the Empire. One feature appealed to him particularly and that was the extraordinary way in which the instructors hid their efficiency. If there was anything which would do no good at all, but would do a great deal of harm, it was hustle, because immediately a man started to hustle a native he ceased to be in any way effective. The instructors went around and did all their work with a sort of happy-go-lucky air, but at their meetings, when they got together and discussed what they had done and their programme for the next month, there was a very different atmosphere. He thought the *ars celare artem* was a very important factor in the work of that particular body. He should like to have the views of the lecturer on the possibility of co-operation for marketing amongst African and other negro producers. The problem was an important one at the present moment and the efficiency of production went hand in hand with it, but production was more easy to deal with than marketing and he should like to hear views on the subject from anyone who could give him information as to attempts at co-operation amongst negro small producers and the possibilities of such co-operation in the future.

Mr. W. F. Hutchison said he had listened with great interest to the paper because he knew the lecturer's record and that he was a friend of the Africans. He himself was an African farmer. He was a native of the Gold Coast and had been engaged for fifteen years planting and farming amongst farmers to many of whom he was bound by the ties of friendship and relationship, and the result of his investigations and work inspired great respect for the African farmer. The African's practice was sound, and he had been very pleased to see that the agricultural officers, the superintendents of agriculture, had been driven to admit that on the whole the native African system of farming had produced excellent results, and a European instructor must make very sure of his ground before he undertook to teach the African on the subject. Great progress was being made in West Africa, especially on the Gold Coast, where attempts were being made amongst them in every way to organise their agriculture. An effort was being made at co-operation in Lagos, where farmers were uniting themselves in a Farmers' Society for the purpose of marketing their products. He asked all those who wished to see African agriculture improved to be very patient, because peasant agriculture was not merely an occupation, but a manner of life, and when the African was asked to change his system of agriculture he was being asked to go through half-a-dozen revolutions, moral and social. In the first place, a change from African to European methods was a change from communism to individualism, which in itself was an enormous revolution. In addition to that, the whole of African life was permeated with religion, and when one changed the African's life and his methods of life it was really asking him to change his religion with all the moral dangers which accompanied the destruction of one religion before there was another religion to take its place.

Mr. John Summerscales thought it was known that natives all over tropical Africa were trying to specialise too much on one crop. In the Gambia almost the entire native population was engaged in the production of ground-nuts. In Uganda cotton counted for 90 per cent. of the total export trade. These specialised money crops were no doubt desirable when the demand was great. But when the demand was low, as in the case of the bumper American cotton crop of 1925, widespread distress was apt to be caused.

Mr. Robert S. Reid said he had listened to the lecture with the greatest possible pleasure, as it almost recited his own history and training as a planter. As a business man he went out to Trinidad forty years ago for the benefit of his health and bought some land in an absolutely derelict little island, Tobago. What the lecturer had said was almost the history of his experience there. The people were at that stage when they had lost the art of working. Thanks to sugar bounties the sugar industry was wiped out, there being only one or two making sugar with windmills. He bought the estate for a song, 5s. per acre freehold, and the vendors were glad to get that because he was the only one that offered anything at all. When he first went to the island it was impossible even to change a sovereign; the people would not change even a five-dollar note because they said they only wished for silver and the note was of no use to them. That was just the history of his education as a planter in Tobago. The people would only plant sugar on a system which the lecturer must know. There was no money to pay wages, and a man who had a plant divided his land amongst his workers, five or ten acres a-piece, and supplied them with the canes which they planted. When the crop season came round the owner of the estate supplied carts and the men cut down the canes and brought

them in and made sugar. After it was made the proprietor received one-half of the sugar and one-half of the molasses and the other half was the wages of the growers. That was a primitive stage of barter. Barter was pretty frequent there, even the parson being paid in chickens, eggs, vegetables, etc. That was only thirty or forty years ago. His own men wanted him to grow sugar, but he said he would grow cocoa instead. The method he adopted was his own idea, and had been followed by much greater men. He arranged to grow a small quantity of cocoa himself; the men were most unwilling, but he doubled their wages and they were perfectly satisfied, though nobody in the place would work more than two days a week. After two years he gave them land to plant cocoa according to the methods the lecturer had explained. In between the cocoa trees they grew foodstuffs. Tobago now was not only covered with big cocoa estates, but had 6,000 proprietors owning from 1 to 1,500 acres. He believed the right method was to encourage the people to develop individuality. The progress in that little island, material, educational and moral, was something remarkable. Those in the West Indies would like more union between all the islands as it would benefit everybody. There were headquarters in the Tropical College for research and it would be possible to get mutual help in their agricultural development

DR. J. M. DALZIEL said that during his years in West Africa he had heard it stated as a gibe that an African farmer with a crop to which he was accustomed could produce better results than his advisers from the Agricultural Department, and in certain instances within limits that would be true. If so, the reason might be related to the fact that the study of soils had only recently been seriously undertaken. It appeared that the result so far as it went was to show that in West Africa almost all soils had a high acidity. As is well known, iron oxide was very widely distributed in that country and the majority of soils there could be classed under laterite in some degree or other. People there began to appreciate that the African, far from being indolent by nature, really deserved to be rehabilitated in reputation having regard to the handicap under which he worked. The improvement of the soil was of paramount importance, whether it was done by manuring or by artificial fertilisers, or by proper rotation of crops, but outside the evergreen forest the most hopeful remedy for the soil was fertilising by stock. Wherever there was grass there was a considerable probability of rearing cattle, especially if the tsetse fly could be abolished. In French Guinea they had gone a stage further and the ox was being increasingly used as a draught animal with the plough and harrow, and one important result was that it was no longer necessary to import rice into French Guinea; in fact, there was now an export of rice. In the words of the Governor of that Colony, only increased energy put into the ground could bring about an increased production, and it was impossible to obtain that excess of energy from the human machine alone. For soils of low fertility the best accessory labour was oxen. In French Guinea ox-ploughed land had proved so much more fertile than when tickled by the hoe that very many families assisted by agricultural credit aimed at possessing ploughs and various other agricultural implements. There were now in French Guinea about 3-4000 ploughs. The natural manure which was obtained produced very good results, and with increased crops there came the idea of individual ownership instead of communal owning. On the Ivory Coast a farmer could get individual ownership although it was contrary to local custom. That was not a principle to be imitated, but he thought it might be suggested that elsewhere in West Africa the rising generation were deciding for themselves that the future of native agriculture would be developed on the line

of small-holdings. They had already got beyond the stage where they cultivated only what was required for the family need, plus the amount needed for the assessment of the native chief. With a money currency crops were having a money value. It seemed almost inevitable that at a time when the family system was being subject to disintegrating influences from many causes the tendency would be for the economic crop to be exploited by individuals of greater initiative, and it was for the agricultural officers to encourage such ambition and to guide it in the direction of improved quality and yield, and at the same time to educate gradually the natives to extend cultivation and to plant along with foodstuffs permanent crops, coffee, cocoa, kola, cotton or bananas, according to the locality.

Lord Olivier, in reply, said he had listened with great pleasure to the contributions made to the discussion and was especially delighted with what Mr. Pooley had said about the Jamaica Agricultural Society being a unique institution. He did not think any Society had done so much work of that particular kind elsewhere in the world. Mr. Pooley had laid his finger upon an idiosyncrasy of the Society, that it had laid itself out to select the proper kind of instructor. To teach an African it was necessary to be humble and aware of one's own ignorance. It was not simply a matter of discovering by scientific methods in the Trinidad Agricultural College what was necessary for cultivation, and then trying to show that to the African, because it was not in his bones to learn in that abrupt manner. It was necessary to go to him and first of all realise that any such comment as " Agriculture is higgledy-piggledy " was beside the question ; it was necessary to recognise at the beginning that to one coming out from England the first impression native agriculture would be certainly an ignorant one, and then it was necessary to learn what was the truth about it, and that could only be done by going amongst the people themselves. He had learned to appreciate negro agriculture and how it should be dealt with by the men who were able to do it. One of these was Mr. Palache, who came from a French family of Haiti, and was a breeder of race horses, was interested in agriculture and found his true vocation in it, and he was a great friend of all the Creoles. He was an extraordinarily sympathetic and understanding man with the negroes, talking their particular patois. Another friend of his was Mr. Walter Jekyll, a devotee of gardening, who lived amongst the mountains in Jamaica and was thoroughly intimate with the negroes and spoke of how the negroes had shown him why they planted a thing here or there and so on—they had a fund of indigenous art. It was necessary to start with what the negro knew and then make suggestions to help him. In Jamaica there were sixteen thoroughly capable instructors. Mr. Arnett was a senior instructor, and what he said about the enormous improvement of negro cultivation might be thoroughly relied upon.
They had got over loafing and dilettantism and a real work was being done, a work which he did not think was being done anywhere else. Another matter was the question of co-operation. Many years ago Mr. Demercado was intensely interested in this question. Being a merchant he was anxious to obtain uniform grades of coffee properly cured, and the Agricultural Society and himself tried to found small co-operative societies to which the natives could bring their berries before they were cured. That method had been one of great difficulty in Jamaica and very little progress had been made. The Jamaica smallholder, as a rule, and still more his wife, had a great idea of marketing and driving a bargain; they went to the market with their little sample and went from buyer to buyer and would not mix up their samples with anybody else's. It was difficult to get them to believe that, if they put in a certain quantity of berries, when the

division came about they would get their fair share. The Jamaica Society had always desired to establish co-operative production and curing, but with very little result. Some success had been achieved in introducing some measure of co-operation through loan banks, and there was now a fairly vigorous institution of co-operative loan banks in Jamaica, which had to be established not by argument but by practical methods. A hurricane occurred in 1903 and it was found necessary, in order to enable the small producers of bananas to re-establish their cultivation, to make them loans, and loans to the amount of nearly £30,000 were made in order to get a banana crop on the ground again. The loans were repaid but he (the speaker) had made it a condition that those who took loans must put their property on the register of title. On the next occasion, when a hurricane occurred, he again said loans would be made and the negroes then knowing their value were keen to have them. There was a great demand for loans and the security was good. He told them he would only make loans if they would make a local co-operative loan bank and take up shares progressively year by year. A practical scheme was developed and the Agricultural Loan Bank had now established a number of branches which were working fairly well. That was the only way of dealing with the African, whom Nature and man had conspired to make an extremely cautious person, or he would not have survived at all. It had been said that there was a great risk in depending on one crop—like the ground nut, for instance—and that was perfectly true. The population of Jamaica depended largely on bananas, which dependence was bad, but it was worse to have the whole population of an island or a country depending on an estate crop like sugar. The negro not only grew bananas and coffee for export, but also grew his own food. It was a dangerous thing to wean an African population from the habit of growing their own food and make them dependent on export crops. It was important to maintain the custom of growing food supplies and help to make the food supply efficient, and then staples might be grown for export. Great Britain had gone a long way from growing its own food and was dependent on trade, but Africa was a long distance from that. The growing of food by the negro was negro agriculture, and that was the work that they were trying to improve in Jamaica. In Uganda a great deal of labour had been diverted from food production to cotton growing. The Government became afraid that there might be a famine and had to take special means to insist on land being put into cultivation again for foodstuffs. He had been very much interested in what Mr. Hutchison said in contributing to the elucidation of the subject, and also in the remarks made by Dr. Dalziel. On the very intractable soil in West Africa it was greatly to the credit of the African people that they had found a system of food cultivation which enabled them to maintain themselves upon it. That was *primâ facie* evidence that African cultivation was not so foolish as it might appear to Europeans. West African negroes were not cattle people and did not know much about cows, although they were in Jamaica fond of horses and good at breeding mules and donkeys. They did not drink milk. The Jamaica Society had largely increased the keeping of small stock. Cows and pigs had to be tethered out. It had been possible to utilise the manure, thereby rendering it unnecessary to continue to change the ground. The negroes had come to understand what could be done in Jamaica. Unquestionably the improvement of negro agriculture must imply that the family plot must remain stable, with a fixity of tenure. Even in the African tribal system particular grounds remained in families, and in South Africa they had definitely attempted to encroach upon the communal systems by giving the land under particular conditions to persons who would cultivate it, and a leasehold title was given to people as long as they cultivated. The effect of building up a system of stable agriculture necessarily implied a fixity of tenure because the manure had to be

kept going continuously. It meant the cessation of the habit of wandering cultivation and an extension of individual property.

A hearty vote of thanks having been accorded to the lecturer, the meeting terminated.

OBITUARY.

Thomas Holmes Blakesley, M.A., M.Inst.C.E. Mr. T H Blakesley, who died at his London home on February 13th, at the age of 81, had been a member of the Society for exactly fifty years, having joined as a Life Fellow in 1879. Born in 1847, he was the second son of the Very Rev. J. W. Blakesley, Dean of Lincoln, and was educated at Charterhouse and King's College, Cambridge, where he graduated as a Wrangler in 1869. Soon after leaving Cambridge he accepted an appointment under the Ceylon Government as an irrigation engineer, and during his residence in Ceylon made a study of the ruins of Sigiri, of which he contributed an account to the Royal Asiatic Society in 1875, and also discovered the existence of a large mass of meteoric iron by the local effect on the magnetic declination. His real bent was in the direction of physical science, and in this field he is to be credited with a number of important researches. He improved the methods of defining and measuring the properties of optical instruments, and invented new forms of lenses and spectroscopes. His work in electricity included researches on alternating currents and allied problems connected with telegraph cables and electrical power transmission. In 1885 he was appointed instructor in physics and mathematics at the Royal Naval College, Greenwich, and this fortunate appointment, which he owed to Professor W. D. Niven, F.R.S., provided him with the necessary facilities for carrying out experimental and research work. Blakesley's studies on the subject of alternating currents were first published in the *Electrician*, and his famous work entitled "Papers on Alternating Currents for the use of Students and Engineers" appeared in 1885. The book ran into four editions and was also published in Germany, France and Russia.

Important as were his contributions to the solution of electrical problems, Blakesley himself regarded the reform of the teaching of geometrical optics to have been the main achievement of his life. In 1897 he read a paper before the Physical Society, in which he explained the principles of his proposed reforms, and published a more complete account in his book entitled "Geometrical Optics," which appeared in 1903. He also contributed to the same Society a description of a new barometer, called the "Amphisbaena," and an important paper on "Logarithmic Lattice-works." His synthetic spectroscope which superimposes three homogeneous portions of the spectrum upon each other, is a beautiful instrument, an example of which was presented by the Mercers' Company, of which Blakesley was Master in 1902 and 1903, to the Finsbury Technical College.

Blakesley remained at the Royal Naval College until 1904, and even in recent years continued his studies in optics and lattice-works, though owing to failing health he was unable to put them into shape for publication. For a number of years he was honorary secretary of the Physical Society, where his happy and kindly disposition was a potent influence in promoting good relations between scientific and industrial physicists.

GENERAL NOTES.

Competition for the Design of a Sign to Denote Petrol Filling Stations and Garages.—A great step forward in the preservation of the amenities of roads throughout the country has now been made possible. Powers have been granted by Parliament to County Councils and Borough Councils to make by-laws for regulating the appearance of petrol stations. It is hoped that something better than the untidy filling stations that are so often to be seen will be the result. In this connection the Home Secretary has appointed a Committee to consider among other things the question of the exhibition of advertisements on petrol filling stations. The Royal Institute of British Architects have been asked to arrange for a competition among architects and other artists for a design for a national sign that will denote filling stations, and a sum of £100 has been allocated for the purpose of providing prizes. Particulars and conditions of the competition can be obtained on application to the Secretary, The Royal Institute of British Architects, 9, Conduit Street, W.1.

Travelling Scholarships in Sanitary Science and Municipal Engineering.—The Chadwick Trustees invite applications for two travelling scholarships of £400 a year each, tenable for one year, to be awarded next July; one scholarship to be in Sanitary Science and the other in Municipal Engineering. The object of the scholarships is to enable the holders to travel abroad to study, either generally or in some particular aspect, the methods adopted in different countries for the prevention of disease and the improvement of public health, or the sanitary administration and engineering applied in urban or rural areas. Candidates must be British subjects, between 25 and 30 years of age, who have graduated in a British University or who can produce evidence of attainments or of intellectual equipment proving them to be capable of methodical study and research. A candidate, prior to appointment, must submit for the approval of the Trustees a scheme of study which he would be prepared to undertake and the itinerary he would propose to follow. Applications should be made by letter before March 25th, 1929, to the Clerk of the Chadwick Trustees at 204, Abbey House, Westminster, S.W.1, stating name, qualifications, age, and proposed object of study or research, accompanied by copies of testimonials and evidence of previous work undertaken or published.

Department of Scientific and Industrial Research. Radio Research. Special Report No. 6.—An Investigation of a Rotating Radio Beacon.—This report describes experiments carried out on a radio beacon transmitter, the aerial system of which consists of a rotating loop or frame coil. After an initial calibration of the beacon a series of tests was carried out in various ships under actual sea-going conditions, in order to establish the reliability of this system of radio direction finding as an aid to marine navigation. In these tests the accuracy of the wireless bearings obtained from the beacon was measured at various distances, and the range of the beacon for reliable working was ascertained. The night errors which were encountered at the longer distances were studied in more detail at various fixed positions chosen to show the effect of transmission over sea and land respectively. In the latter part of the investigation a direct comparison was made both at sea and on land between the bearings observed on the rotating beacon and those obtainable with a direction finder used in the ordinary manner.

As a result of such experiments it is shown in the report that the rotating loop beacon can give reliable bearings of the same order of accuracy and at similar ranges as those obtainable with other systems of wireless direction finding under the most favourable conditions. A great advantage possessed by the rotating beacon system is that it requires only an ordinary wireless receiver and a suitable watch to enable a ship to take bearings, and that the method overcomes certain disadvantages met with when using direction finders on board ship, particularly in the case of small ships. It is, therefore, likely that this system will prove of considerable value in the application of wireless to marine navigation. The report, which contains six illustrations in the text and seven plates, can be obtained, price 2*s.* 3*d.* (postage extra) from H.M. Stationery Office, Adastral House, Kingsway, W.C.2, or through any bookseller.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.—ENGINEERING RESEARCH. SPECIAL REPORT NO. 3. THE CAUSES OF FAILURE OF WROUGHT IRON CHAINS.—Many cases have been encountered in practice in which wrought iron chains have failed under circumstances where such factors as gross overloading or defective material could be excluded. The present report describes an investigation which has been conducted at the National Physical Laboratory with the object of determining the conditions under which wrought iron chains become liable to sudden failure in a manner usually associated with brittle materials. The desirability of periodical annealing as a restorative treatment has also been investigated. Experiments on chains taken from service of known history, together with a large number of laboratory experiments, have shown that the main cause of deterioration in service of wrought iron chains is the production on the links of a hardened skin by repeated small impacts. These impacts are received in the movement of link on link, hammering on the ground, rattling through hawse pipes and similar actions. The existence of this thin brittle skin renders the chain link extremely liable to sudden failure under quite small stresses. The application of bending forces, particularly those due to shock, produces in the hardened skin a crack of such a shape that great stress concentrations occur at its root, and consequently the crack passes on through the entire section of the link with the absorption of very little energy. Annealing at a dull red heat causes recrystallisation and softening of the hardened skin, thus restoring the link to its normal ductile state. Normalising from 1,000° C. produces the same result. The relative merits of annealing and normalising are fully discussed. The Report, a Royal octavo volume containing 167 pages and 91 illustrations, may be obtained, price 7s. 6d. net (postage extra), from H.M. Stationery Office, Adastral House, Kingsway, W.C.2, or through any bookseller.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 4..Aeronautical Society, at the Institution of Electrical Engineers, Savoy Place, W.C. 6.30 p.m. Group-Captain H. M. Cave-Browne-Cave, "Royal Air Force Far-East Flight."

Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Dr. Leonard Hill, "Modern Methods of Heating and Ventilation."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. 1. Prof. A. R. Ling, "Recent Advances in the Chemistry of Polysaccharides and Allied Compounds." 2. Dr. F. W. Norris, "Recent Researches of Pectous Substances."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Variable-Speed Alternating-Current Motors," opened by Mr. L. J. Hunt.

At the University, Edmund Street, Birmingham. 7 p.m Discussion on "The Anticipation of Demand and the Economic Selection, Provision and Layout of Plant," with introductory papers by Capt. J. M. Donaldson (Power Systems) and Mr. J. G. Hines (Telephone Systems).

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. H. R. Lordly, "The Waterproofing of Concrete Structures."

Farmers' Club, at the Whitehall Rooms, Northumberland Avenue, S.W. 4 p.m. Sir John Russell, "Farming in Australasia: its Bearing on British Farming."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mrs. Gordon-Gallien, Mr. J. W. Cornwall and Mr. Colin C. Rose, "The Kalambo Falls, Northern Rhodesia."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. P. L. Thompson, "Recent Developments in Town Planning."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. A. R. Short, "Recent Literature concerning the Origin of Species."
University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture II.)
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Paul Vacher, "Present Aspects of French Politics." (Lecture III.)
At University College, Gower Street, W.C. 2 p.m. Prof. Dr. A. W. Reed, "Victorian England."
5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture IV.)
At University College Hospital Medical School, Gower Street, W.C. 5.30 p.m. Dr. A. Maitland Ramsay, "The Eye in General Medicine." (Lecture I.)

TUESDAY, MARCH 5..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Mr. A. E. L. Chorlton, "The Heavy Oil Engine on Road and Rail."
Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Conrad Gribble, "Impact in Railway Bridges, with particular reference to the Report of the Bridge Stress Committee."
Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."
Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.
Industrial Transport Association, at Australia House, Strand, W.C. 6.30 p.m. Mr. John H. Stirk, "Canadian and American Travel and Transport."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture VI.)
United Service Institution, Whitehall, S.W. 3.30 p.m Anniversary Meeting.
University of London, at the Institution of Electrical Engideers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture V.)
At King's College, Strand, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Eastern Question" (Lecture VIII.)
5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Traction" (Lecture IV.)
At University College, Gower Street, W.C. 5.30 p.m. Lecture on "The Current Work of the Biometric and Eugenics Laboratories." (Lecture VI.)
Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, MARCH 6..Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Mr. A. L. Andrew, "The Cryoscopic Method for the Detection of Added Water in Milk. (2) Christine M. Fear, "The Alkaloid Test for Tannin."
Geological Society, Burlington House, W. 5.30 p.m Mrs. M. M. Ogilvie Gordon, D.Sc., "The Structure of the Western Dolomites."
Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Dr. B. J. Owen, "The Dessication of Vegetable Material."
Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.
Roman Studies, Society for the Promotion of, at Burlington House, W. 4.30 p.m. Lecture by Mr. R. P. Longden.
United Service Institution, Whitehall, S.W. 3 p.m. Captain J. V. Creagh, "The Fleet of the Future."
University of London, at King's College, Strand, W.C. 5 p.m. The Rt. Hon. Sir Frederick Pollock, "Judicial Caution and Valour."
5.30 p.m. "The Social Background of English History." (Lecture VIII.)—Sir Charles Allom, "English Woodwork and Furniture."
5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture VIII).
At the London School of Economics, Houghton Street, W.C. 6 p.m. Capt. V. W. Garwood, "Coin-counting Machines."
At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist, and Rydberg." (Lecture II.)
At University College Hospital Medical School, Gower Street, W.C. 5.30 p.m. Dr. A. Maitland Ramsay, "The Eye in General Medicine." (Lecture II.)

THURSDAY, MARCH 7..Aeronautical Society, at the Roya Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. C. N. H. Lock, "Airscrew Body Interference."
Chemical Society, Burlington House, W. 8 p.m. 1. Mr. F. G. Mann, "The Stability of Complex Metallic Salts." 2. Mr. A. B. Manning, "The Determination of Unsaturated and Aromatic Hydrocarbons in Light Oils and Motor Spirits." 3. Mr. S. Glasstone, "Studies of Electrolytic Polarisation. Part VII. Complex Cyanides. (a) Silver." 4. Mr. S. Glasstone, "Studies of Electrolytic Polarisation. Part VIII. Complex Cyanides. (b) Copper."
Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Mr. E. S. Ritter, "Picture Telegraphy."
L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Sydney J. Davies, "Some of London's Heirlooms of Industry."
Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. J. G. Weir, "Modern Feed-Water Circuits."
At the Engineers' Club, Manchester. 7.15 p.m. Mr. A. B. Winterbottom, "Heat Insulation."
Oil and Colour Chemists' Association, at the Painters' Hall, Little Trinity Lane, E.C. 7.30 p.m. Continuation of Discussion of "The Painting of Cement and Plaster." (Joint Meeting with Incorporated Institute of British Decorators.)
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Use of Language and its Difficulties."
Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-upon-Tyne. 7.30 p.m. Mr. E. McClelland, "Some Aspects of Selling Rail Travel."
University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture IV.)
5.30 p.m. M. Marcu Beza, "Byzantine Influences on Roumanian Literature." (Lecture I.)
5.30 p.m. "Czechoslovakia." (Lecture VIII.)—Mr. J. Hanc, "Modern Currents in Czechoslovak Art and Culture."
(King's College.) At 40, Torrington Square, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Early Civilisation of the Slavs." (Lecture I.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture I.)
5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: a Course for Laymen." (Lecture III.)
5.30 p.m. Signor A. M. Bassani, "Nicolo Tommaseo" (in Italian).

FRIDAY, MARCH 8..Astronomical Society, Burlington House, W. 5 p.m.
Malacological Society, at University College, Gower Street, W.C. 6 p.m.
Metals, Institute of, at the University, St. George's Square, Sheffield. 7.30 p.m. Messrs. D. F. Campbell and W. S. Gifford, "Progress of Electric Furnaces."
Oil and Colour Chemists' Association, at Milton Hall, Manchester. 7.30 p.m. Mr. S. T. Kinsman, "A few Notes on the Fastness to Light of Lake Colours."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1. Dr. Ezer Griffiths, and Mr. J. H. Awbery, "The Dependence of the Mobility of Ions in Air on the Relative Humidity." 2. Prof. A. M. Tyndall, "Some unsolved Problems relating to the Mobility of Gaseous Ions." General Discussion on the Mobility of ions.
Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. T. F. Tout, "The Place of Women in Later Medieval Civilization."
University of London (King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture III.)
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology."
5.30 p.m. Dr. J. Howard Jones, "Hygiene of the Mercantile Marine." (Lecture III.)
At University College Hospital Medical School, Gower Street, W.C. 5.30 p.m. Dr. A. Maitland Ramsay, "The Eye in General Medicine." (Lecture III.)

SATURDAY, MARCH 9..L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. R. W. Sloley, "The Cave-Artists of the Stone Age."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases." (Lecture II.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3981. VOL. LXXVII.

FRIDAY, MARCH 8th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 13th, at 8 p.m. (Ordinary Meeting.) R. P. G. DENMAN, A.M.I.E.E. (of the Science Museum, South Kensington), "Loud Speakers." DR. WILLIAM HENRY ECCLES, D.Sc., F.R.S., will preside.

SHAW LECTURES.

MONDAY, FEBRUARY 25th, 1929. SIR THOMAS MORISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the second of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting, at which THE RIGHT HON. J. RAMSAY MACDONALD, M.P., presided, of subscribers to the Fund for the Preservation of Ancient Cottages was held on Wednesday, February 27th. A resolution that the report of progress up to 31st December, 1928, which had been previously circulated, should be adopted, was proposed by the Chairman, and supported by Mr. G. K. CHESTERTON, SIR CHARLES WAKEFIELD, Bt., C.B.E., MR. H. AVRAY TIPPING, F.S.A., and LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O. At the conclusion of the meeting a vote of thanks to the Chairman was proposed by SIR GEORGE SUTTON, Bt., Chairman of the Council, and carried unanimously.

A full report of the meeting will be published in the *Journal* at an early date.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 27th, 1929. DR. L. A. JORDAN, D.Sc., A.R.C.S., in the Chair.

A paper on "East Indian Copals and Damars" was read by MR. A. F. SUTER. The paper and discussion will be published in the *Journal* dated April 26th.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 13TH, 1929.

MR. H. V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, in the Chair.

The following Paper was read :—

THE STUDY OF THE ORDER OF FLOWERING AND POLLINATION OF FRUIT BLOSSOMS APPLIED TO COMMERCIAL FRUIT GROWING.

By CECIL H. HOOPER, F.L.S., M.R.A.C., F.S.I., OF WYE, KENT.

The object of this paper is to show that observations of fruit blossoms and their insect visitors may be used as a guide in orchard planting and in the increase of the crop of fruit.

It is granted that many things are necessary in order to secure a good and profitable fruit crop ; one naturally thinks of the need for healthy trees, efficient drainage, suitable soil, proper cultivation, freedom or protection from diseases and insect pests, kindly weather especially at blossoming time, and, lastly, a remunerative market.

Botany, however, teaches us that the pollination of fruit is well worth careful and thoughtful study as without fertilisation fruit is not produced.

By pollination is meant the transference of pollen grains from the anthers to the stigmas ; the pollen grain there germinates, throwing out a pollen tube which travels through the style to fertilise the ovule, which then becomes a seed and around which the fleshy fruit forms.

Agricultural and horticultural research has devoted much of its energy to explaining why many good practices which have been long in existence are right (liming, for example). Our forefathers planted orchards of mixed varieties, whether it was of apples or cherries, and kept bees ; recent research on fruit pollination has proved that both were good practices.

The Arabs, certainly as far back as the time of Mahomet, cut pollen-bearing branches from the male date palms, carried them up the fruit-bearing trees

and tied them among the branches for the wind to distribute the pollen. The Turks must have long known that without a certain little wasp they could not get a crop of Smyrna figs. Probably neither the Arab nor the Turk would satisfy the botany examiner of London University as to his knowledge of fruit pollination, but observation and experience have taught each a great deal, and it has been left for recent years to explain the facts in botanical terms.

In growing our common English fruits we get examples of wind and insect pollination ; self and cross fertilization.

Wind Pollination.

Cob and filbert nuts and walnuts each produce dust like pollen which is carried by the wind to the female flowers ; in each of these botanical observation has something to teach. To ensure a crop it is necessary that the pollen be shed at the time that the stigmas of the little nut flowers are receptive. The catkin-bearing branches must not be pruned off before the nut flowers are fertilised ; some varieties do not bear many catkins, and in some kinds the time of pollen shedding and of the nut flower blossom do not syncronize, so that it may be advantageous to have a few trees of another variety to assist the pollination. The late Mr. George Bunyard recommended planting an occasional Cosford Cob through the nut plantation, it being a variety that bears many catkins. Professor E. J. Wickson, of California University, has shown that for growing walnuts commercially it is advisable to inter-plant several varieties, as in some sorts the pollen is shed too early or too late for the female flowers on the same tree. In the garden of an uncle at Sheldwich, Kent, there were two walnut trees standing about ten yards apart ; one was a soft-shelled walnut, the other a hard-shelled walnut ; he kept an account of the yield, and in 30 years the trees bore 340 bushels of nuts, which sold for £69 8s. (besides some kept for the house). I believe the good and regular yield was due to the fact that they were different varieties and cross-pollinated one another efficiently.

Insect Pollinated Fruits.

The *strawberry* is pollinated both by wind and insects. *Raspberries* and *Loganberries* are perfectly self-fruitful, *i.e.*, they mature fruit perfectly with pollen of the same plant, but they need insects to carry the pollen. If insects are excluded from the blossoms, the fruit is imperfect and deformed. Hive bees are very fond of raspberries, and undoubtedly increase the crop, and the raspberry is one of the best plants for honey production.

Gooseberries, *red currants* and *black currants* all mature fruit perfectly with pollen of the same plant, but their pollen is glutinous, like minute grains of boiled sago, which clings together and cannot be transported by the wind, so they are dependent on insects to carry it from the anthers to the stigmas.

Where a large acreage of gooseberries or black currants is grown, there may not be sufficient wild insects to visit the blossoms, and growers find that by placing hives of bees in the plantations they get more fruit.

FRUIT TREES.

In fruit trees profuse blossoming does not necessarily foretell a large crop; weak trees sometimes flower excessively to the disadvantage of maturing fruit; super-abundance of flowers apparently wastes energy.

In the case of apples, cherries, pears and plums it is found that the blossoms are practically entirely dependent on insects for fertilization; experiments show that wind carries very little of the pollen from flower to flower. In these fruits a new factor comes in, *viz.*, that a large number of the varieties will not mature fruit when pollinated by pollen of the same variety. A new variety is originated as a seedling and is propagated by budding and grafting on other stocks; consequently, the pollen is similar whether it comes from the same flower, the same tree, or another tree of the same variety, though it may be growing at a distance.

Self-fertile or *self-fruitful* is a term applied to a variety that matures a considerable proportion of its blossoms into fruit with pollen of the same variety.

Partially self-fruitful means that only a small proportion of the flowers will mature fruit with pollen of the same variety.

Self-sterile is a term applied to varieties that will mature no fruit with their own pollen, or mature only perhaps one fruit in a thousand blossoms, which is for practical purposes self-sterile; there are varieties, such as Cox's Orange Pippin, and Lane's Prince Albert, which in many trials have shown themselves to be self-sterile, although one flower out of 2,000 may eventually mature a fruit under glass after several years of trial.

Of apples grown in the open about two-thirds of the varieties appear to be self-sterile, and no variety is sufficiently self-fruitful to plant profitably in a block alone.

About half the varieties of pears are somewhat self-fruitful, but they are relatively less self-fruitful than apples.

With plums, about half are more or less self-fruitful and half are self-sterile, or nearly so.

Among cherries, Morello is perfectly self-fertile, Flemish and Kentish preserving cherries and May Duke are to a small extent self-fertile, but the sweet cherry varieties are all either absolutely self-sterile, or self-fruitful to the extent of only one or two per cent. It is consequently not surprising that there are cherry orchards which year by year crop badly, especially as some varieties of cherry are inter-sterile, *i.e.*, will not mature fruit with pollen of the other variety.

As cross-pollination is shown to be beneficial in increasing the crop, it is

necessary to ascertain that the varieties which it is proposed to plant together flower at about the same time ; one should avoid planting early flowering with late flowering, unless there is a mid-season flowering variety which will pollinate both.

It may be stated that, provided the two varieties are in flower at the same time, the pollen of one variety is as good in the production of fruit as is another : in the U.S.A. in experiments with apples some varieties are found to cross-pollinate better than others ; personally, I believe there is a difference (especially in some of the shyer bearing varieties) and that a variety may bear more fruit with one kind of pollen than with that of another. I think this may be more the case with fruit grown in the open than that grown in the more comfortable glass house.

It is interesting to find that different varieties of the various fruits flower in a definite order in the same way as the flowers of the countryside, where the snowdrop is followed by the aconite, the crocus by the hazel, lesser celandine by the coltsfoot, almond by wood anemone, and so forth ; in like manner the different varieties of pear, plum, apple and cherry flower in fairly regular succession. In former days orchards were planted with a large number of varieties which mutually cross-pollinated one another, but in wishing to lessen the number of varieties and in order to grow a large quantity of a remunerative variety, some orchards have been planted with one variety only, or with two varieties that do not flower at the same time or, in the case of some cherry orchards, with varieties that do not cross-pollinate.

Careful records of the order of flowering of apples, pears and plums have been kept at six or eight observation stations in Australia for several years and these records correspond fairly nearly with those kept in England ; thus Black Diamond plum flowers early and Pond's Seedling late ; in pears, Brockworth Park flowers the earliest with Keiffer's Hybrid, whilst Williams's Bon Chrêtien, Marie Louise, Glou Morceau and Beurré Capiaumont flower late, showing that the order of blossoming in Australia closely resembles that in England. In Australia many more English varieties of apples, pears, plums and cherries are grown than in Canada and the U.S.A.; one wonders why European varieties of apples should thrive better in Australia than they do in America; very few American varieties of apple succeed in England.

PEARS.

Pears are of special interest in the history of research in fruit pollination, as it was in 1890 that Mr. M. B. Waite was asked by the Department of Agriculture of the U.S.A. to investigate the cause of unfruitfulness of an orchard of 22,000 Williams's Bon Chrêtien trees which, although planted fifteen years and healthy, hardly yielded any fruit. In this orchard it happened that three trees of different varieties had been planted by mistake among the Williams (two Clapp's Favourite and one Buffam). In the neighbourhood of these three trees the

Williams were very productive, bearing down the branches to the ground with the weight of the fruit. His previous experiments led Mr. Waite to believe that this limited and local abundance was caused by cross-fertilisation from the other trees, and this view was fully confirmed by all his subsequent experiments. I had an example of the importance of pollination in pear, though on a very small scale, when fruit farming at Swanley, Kent; I planted 48 Pitmaston Duchess trees in an apple orchard on flat land rather low; although for four years they flowered well, they did not mature a single fruit. I therefore had them taken up and replanted them on a hill side about a quarter of a mile away in a plantation of pears of different sorts and placed a hive of bees amongst them; the trees then bore well.

In my own experiments I have found the following varieties more or less self-fruitful:—Conference, Dr. Jules Guyot, Chalk, Beurré d'Amanlis, Swan's Egg, Colmar d'été, Duchesse d'Augoulême, Marguerite Marillat, Winter Windsor, Jargonelle, Souvenir du Congrès, Beurré Jean van Geert, Beurré Diel, Durondeau, Petite Marguerite, Blickling and Glou Morceau. Only one fruit from each has matured with me out of many trials with Pitmaston, Williams and Doyenne du Comice. No fruit matured in my trials with own pollen from Clapp's Favourite, Fertility, Emile d'Heyst or Catillac.

At the Royal Horticultural Society's Gardens, at Wisley, Mr. Chittenden and Mr. Rawes have experimented to a considerable extent on the pollination of pears as well as of apples and plums; in a recent letter Mr. Chittenden gave me the names of fifty-two varieties that had been found to be self-fertile to a greater or lesser extent under glass, and of forty-four that had not so far matured fruit with pollen of the same variety.

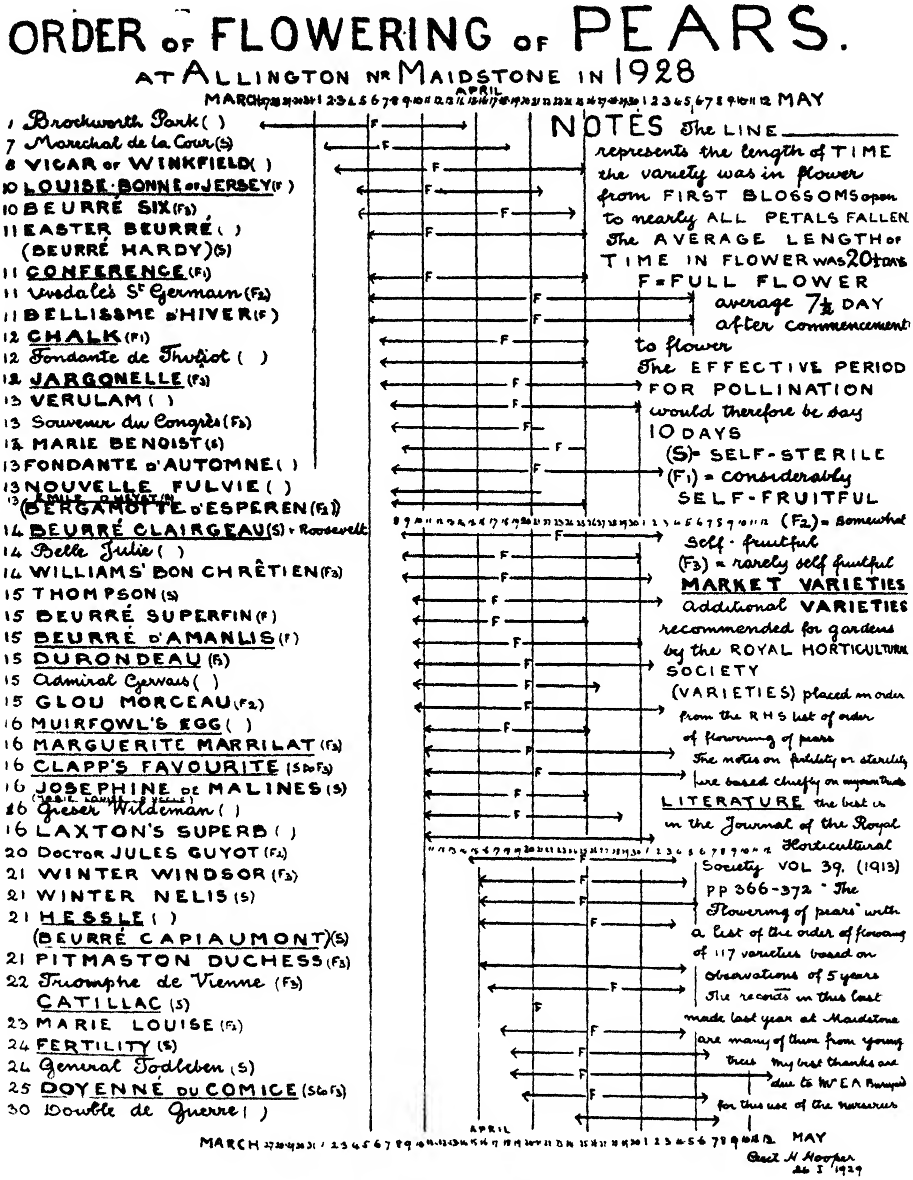
In pears some of the best varieties are shy bearers. Last year I tried twenty-six different kinds of pollen with Doyenne du Comice but only from six of these did fruit mature; these were from pollen of Hessle, Triomphe de Vienne, Fertility, Gregoire Bourdillon and Madame Lye Baltet; but another year many of the other varieties which failed might mature good fruit.

Careful observations in successful and unsuccessful pear plantations might yield many facts and suggestions which might be checked by pollination trials.

Among successful pollination results were:—Clapp's Favourite with Conference; Dr. Jules Guyot with Clapp's Favourite, Roosevelt; Fertility with Conference; Durondeau with Fertility; General Todleben with Conference; Vicar of Winkfield with Winter Cresanne; Williams's Bon Chrêtien with Clapp's Favourite, Winter Cresanne or Fertility; Pitmaston with Conference or Williams's Bon Chrêtien; Uvedale's St. Germain with Marie Louise; Catillac with Fertility or Uvedale's St. Germain.

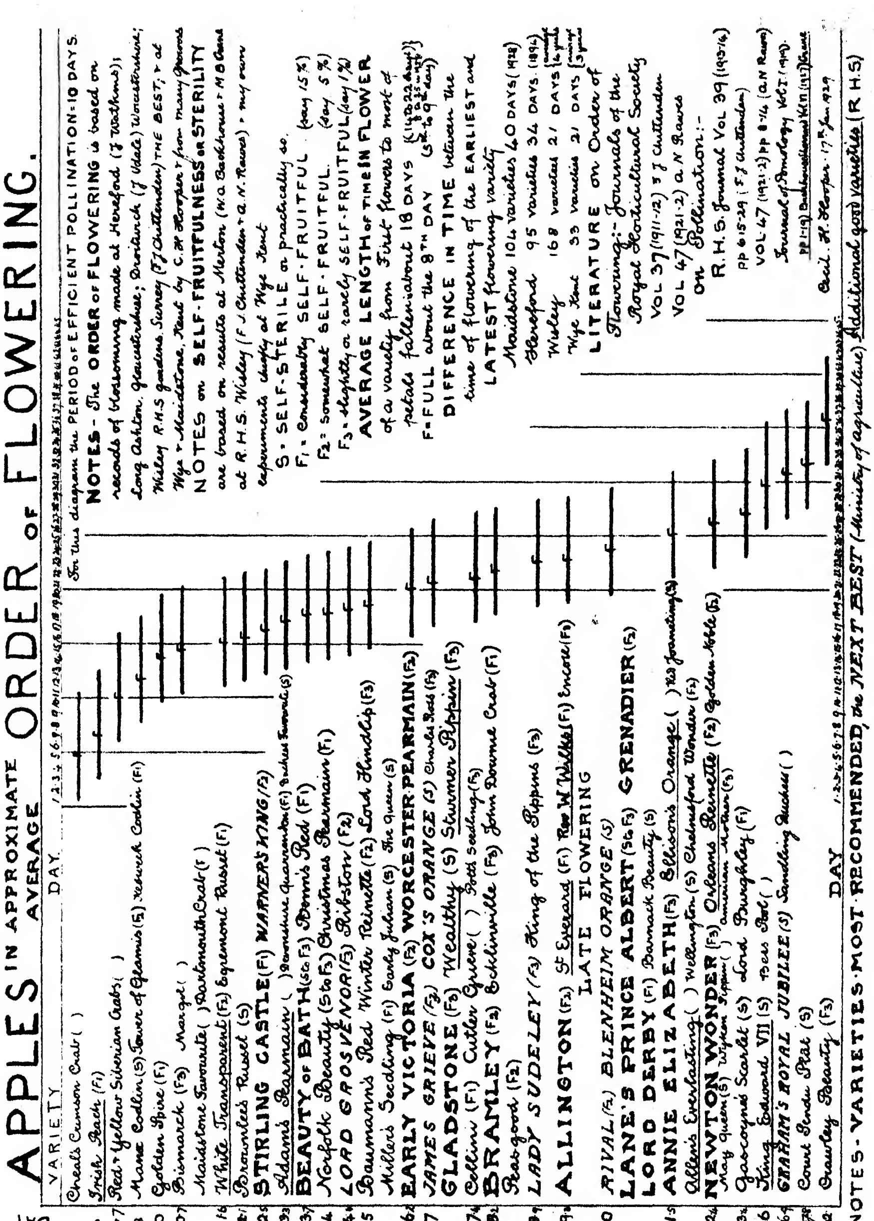
Apples.

Although a considerable proportion of apples are gradually being shown to be more or less self-fruitful (under glass, varying from 7% down to 0.2%),



Approximate order of flowering of Pears.

yet all experimenters agree that no single variety can be advantageously planted alone and that all varieties yield more if interplanted with one or more varieties in flower at the same time. Even the most self-fruitful variety will yield three or four times the crop with other varieties than if planted alone.



Approximate order of flowering of Apples.

In 1910 I placed three paper bags over unopened blossoms on trees of 63 different varieties of apple, with the following results:—1. with insects excluded only "Irish Peach" matured fruit; 2. flowers pollinated with own pollen, eleven varieties matured fruit; 3. flowers pollinated with a different

pollen, forty-eight varieties matured fruit. These were single trials in each case, but my experience since is that this gives a fairly correct idea of apple pollination in the open air. Among the varieties found most self-fruitful are :—Stirling Castle ; Rev. W. Wilks ; Golden Spire ; Irish Peach ; Christmas Pearmain ; Baumann's Red Winter Reinette ; Ben's Red ; Miller's Seedling ; Lord Derby ; White Transparent and Tower of Glamis, but with many trials I have never persuaded Cox's Orange or Lane's Prince Albert to mature fruit with their own pollens.

Where a variety has been planted alone in block, it is recommended to re-graft or replace one tree in eight with a different variety flowering about the same time ; Bramley's Seedling is found to be a specially good variety with which to re-graft. Each third tree in each third row of a different variety is considered the minimum proportion for a pollenising variety.

In planting a new orchard it is advisable to plant not more than two or three rows of one variety and then alternate with another variety.

Experience and experiment show the following to be good varieties to plant together, though other combinations may succeed equally well :—Cox's Orange with Worcester ; Bramley with Lane's ; Newton with Lord Derby ; Blenheim with Newton ; Early Victoria with Grenadier ; Beauty of Bath with Allington ; James Grieve with Cox's Orange ; Gladstone with Cox's Orange or Worcester. In many trials I have found Cox's Orange to be a good polleniser ; the crosses have almost always taken and matured fruit.

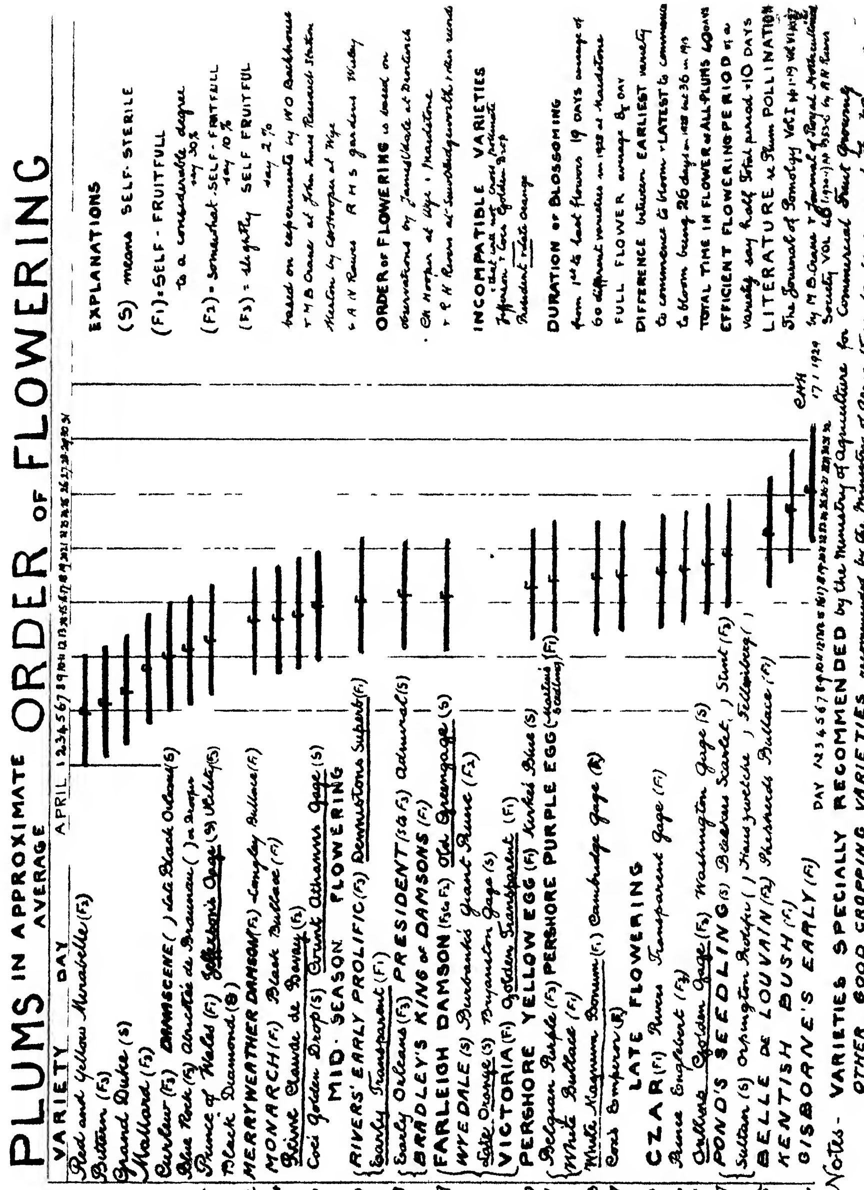
PLUMS.

Plums are grouped according to pollination experiments into three classes 1. those that are considerably self-fruitful ; 2. those that are absolutely or very nearly self-sterile ; and 3. a few that are partially or slightly self-fruitful. The most self-fruitful group includes :—Pershore Yellow Egg, Pershore Purple, Victoria, Czar, Denniston's Superb, Monarch, Shepherd's Bullace, Kentish Bush, Early Transparent, Prince of Wales, Bradley's King of Damsons and Gisborne.

The partially self-fruitful varieties include:—Rivers' Early Prolific, Early Orleans, Cox's Emperor, Prince Englebert and Belgian Purple, whilst the self-sterile varieties include :—Pond's Seedling, Greengage, Jefferson, Bryanston, Late Orange, President and Coe's Golden Drop.

Of the self-fruitful varieties Pershore Yellow Egg plum fruits perfectly in Worcestershire without other variety, and yields as heavily as potatoes, but all the other kinds yield more heavily if pollinated with pollen of another variety.

Some suggestions based on pollination experiments and orchard practice may be found useful. Rivers' Early Prolific crops well with Prince of Wales, Czar or Monarch ; Pond's Seedling with Czar, Kentish Bush or Belle de Louvain; Belle de Louvain with Czar or Kentish Bush ; Monarch with Rivers' Early



Approximate order of flowering of Plums.

Prolific or Prince of Wales; President with Czar; Victoria with Czar; Oullin's Golden Gage with Pershore Purple.

For the three specially shy bearing kinds Mr. M. B. Crane of the John Innes Horticultural Institution tells me that for Coe's Golden Drop he has found

Pond's Seedling, Rivers' Early Prolific and Monarch to be good pollenizers; for Greengage he has found Pershore Yellow Egg, Pond's Seedling, Czar, Early Orleans or Bradley's King of Damsons to be good pollenizers and for Bryanston Gage, Rivers' Early Prolific. At Wye there is a fruit garden of several acres enclosed by a circular wall about nine feet high; on this wall are trained trees of different varieties of plums, and there are three hives of bees in the garden. These shy bearing plums all fruit here almost as plentifully and regularly as the Victoria.

Mr. Crane finds that:— (1) President, Late Orange, Cambridge gage are inter-sterile; also (2) Coe's Golden Drop and Jefferson, so these several sorts are unsuited to plant together alone for cross-pollination.

CHERRIES.

The Agricultural College of Wageningen, Holland, has just published a pamphlet on cherry pollination which ends with the following advice to cherry growers:

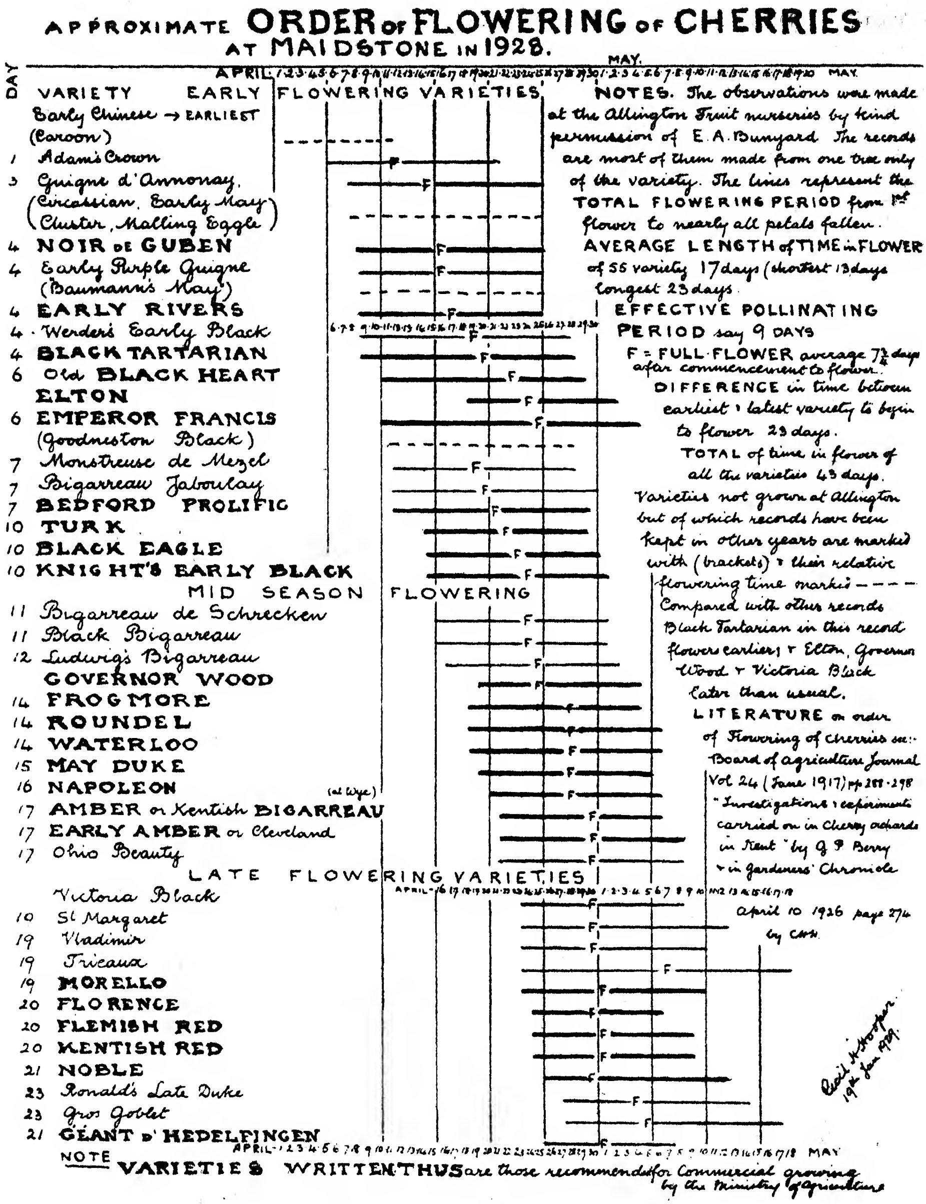
1. In planting an orchard, plant two or more varieties in such a way that every tree of one variety has a tree of another sort next to it on one side at least.

2. Keep a good number of hive bees in the cherry orchard during the blossoming period.

In 1913 Mr. V. R. Gardner, of the Oregon Agricultural College Experiment Station, published a bulletin showing that different crosses in cherries gave different yields; besides showing that sweet cherries were in general absolutely self-sterile, he proved that the three chief varieties, Bing, Lambert and Napoleon were inter-sterile, *i.e.*, would not cross-pollinate each other. Investigations in England at Merton and Wye have shown that most of the sweet cherries are absolutely self-sterile, or if at all self-fruitful only to the extent of about one per cent., which does not help much towards a crop; cross pollination is therefore of very great importance in sweet cherries.

The Duke cherries are slightly self-fruitful and appear to be best pollinated by other Duke varieties and by Morello. Flemish and Kentish Red preserving cherries are somewhat self-fruitful, but need cross-pollination. There is a plantation of Flemish cherries near Ramsgate which has been inter-planted with Kentish Red; the crop is generally good and regular, so this seems to be a good practice. The Morello cherry is perfectly self-fruitful; nothing is gained by cross-pollination; this is the only cherry that can be safely planted alone.

Mr. M. B. Crane, at the John Innes Horticultural Institution, in his valuable investigations has found that among the varieties grown in England there are groups of cherries that are inter-sterile, and that one should avoid planting them together alone. These are:—1. Early Rivers, Knight's Early Black, Bedfordshire Prolific, Black Tartarian and Black Eagle. 2. Frogmore, Waterloo, Guigne de Winkler and Bigarreau de Schrecken. 3. Napoleon and Emperor Francis.

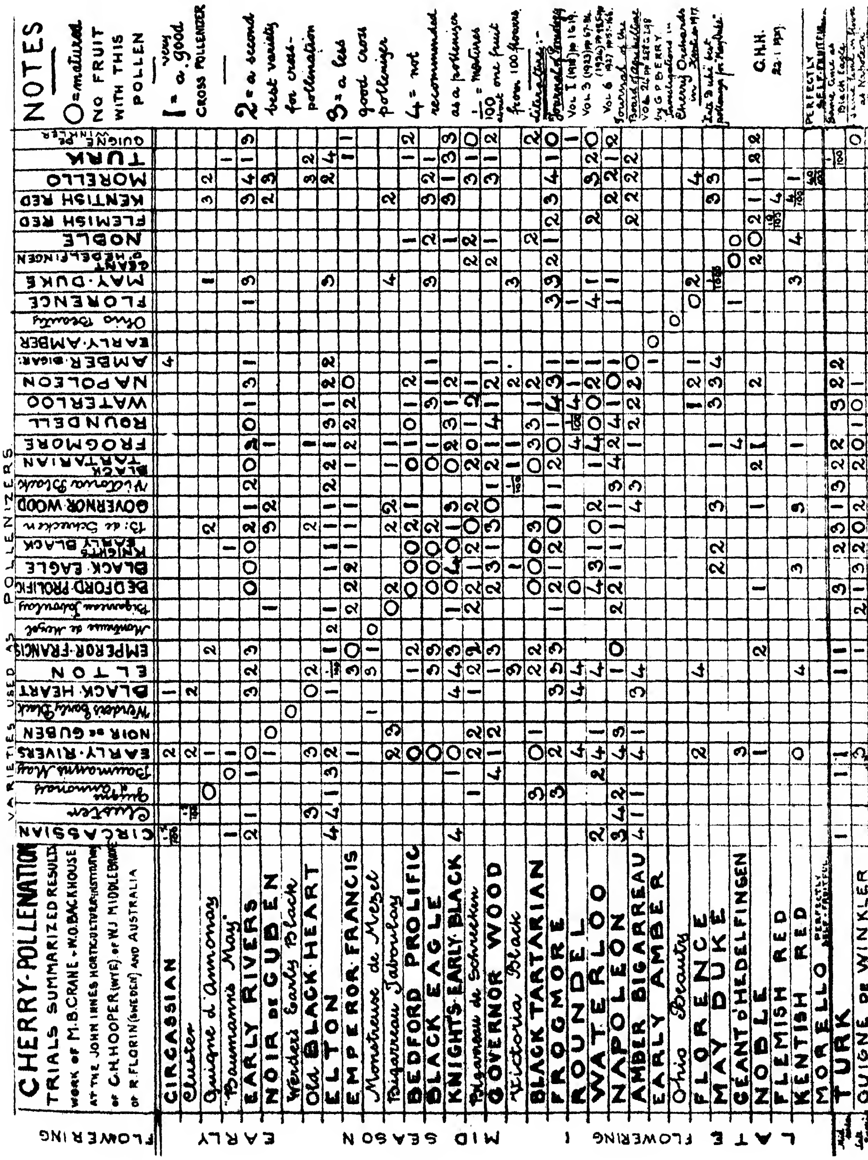


Approximate order of flowering of Cherries.

Early Rivers being the most profitable cherry has sometimes been planted alone in large quantities, when it is found that the inside trees bear very little fruit. Some growers (Sir Walter Berry at Selling, Mr. A. J. Thomas at Rodmersham, and Mr. H. Stevens at Wye) have each found that a variety

known as "Baumann's May" is a good cross-pollenizer for Early Rivers; it flowers at the same time and the fruit is ripe soon after Early Rivers, which it resembles.

In choosing varieties to plant together one needs to avoid planting early flowering with late flowering varieties alone; a mid season flowering sort might pollenate both the early and the late flowering varieties, bridging the difference in time of flowering.



Chart—showing results of cross-pollination of Cherries.

I have made a table collected from the results of experiments and orchard observation from several sources which I hope may act as a guide in choosing varieties suitable to plant together.

The most productive cherry orchards I know are planted with several varieties, and bees are kept in the orchards. If one cannot manage to have one hive per acre, have a hive to five acres. It will be found to be far better than having none.

An excellent bulletin on "Pollination and Growing of the Cherry" by C. E. Schuster was published in 1925 by the Oregon Agricultural College Experiment Station.

INSECT VISITORS TO FRUIT BLOSSOMS.

I had hoped this evening to devote a good deal of time to the insect visitors but the length of the paper does not allow it.

There are a great many different kinds of insects that visit fruit blossoms, especially the apple.

For several years I made brief notes of those I noticed and added up their numbers, which are given in the attached table. I am glad to say since I made my observations as a mere naturalist, Mr. J. Fox Wilson, as a trained entomologist, has made a far more complete list at the Royal Horticultural Society's Gardens, at Wisley, Surrey, and I would refer anyone interested in the subject to his well-illustrated report in the *Journal of the Royal Horticultural Society* for 1926.

Mr. Fox Wilson's and my records differ in some ways. The Royal Horticultural Society's gardens are surrounded by common and woods; there was not a large acreage of fruit, and the nearest hive of bees was about three-quarters of a mile distant, so wild insects were very numerous and hive bees not so numerous. At Wye there is a considerable acreage of cherry, apple and other fruits, and a good many hives of bees are kept; the surrounding land is arable land and sheep pasture, which are not very favourable habitats for pollinating insects.

All entomologists who have studied the subject of fruit pollination agree that the bee family, owing to the structure of the insects and their habit of keeping to one kind of flower on a journey, are by far the best fruit pollenizers of all insects.

The bumble bees and the small wild bees do splendid work, but they are out of human control and cannot be increased in number. With high cultivation wire fences replace hedgerows; so that the banks and woods where the wild bees make their home decrease in area; thus the hive bee relatively increases in value.

Where there are large blocks of fruit the pollination by insects is out of proportion to the capacity of the local wild insects, and it is therefore of great value to place hives of bees in different parts so as to have them near the black

NUMBERS OF DIFFERENT KINDS OF INSECTS VISITING FRUIT BLOSSOMS.

Fruit.	Hive bees.	Bumble bees	Small wild bees (Andrena & Halictus).	Blue bottle flies.	Other flies.	Beetles.	Ants.	Earwigs.	Thrips.	Other Insects.	Notes.
Almond ...	6										
Peach ...	9	5		2		1					
Pear	172	2	11	16	2					3	(2 midges, 1 white butterfly).
Plum	23	17	35	2	1						
Gooseberry ...	57	17	1		1					1	(1 wasp) (1 yellow fly).
Cherry ...	103	92	16							1	(1 spider).
Red Currant ...	10	1			1						(1 yellow fly)
Black Currant	36	12	5							1	
Apple ...	374	37	21		23	104	51	3	2		(beetles include 24 weevils)
Strawberry ...											a few hive bees
Raspberry ... (recorded by Mr. H. Chapelow)	797	32			24						
Loganberry ... (recorded by Mr. H. Chapelow)	1292	61			79						
Quince... ...	4						many				

Recorded by C. H. Hooper at Wye, Kent.

currants and cherries and other fruit to carry pollen when the weather is suitable.

The American fruit growers keep bees extensively for the fertilization of the blossoms rather than for the honey. In England one finds that many of the most painstaking and successful fruit growers keep bees with the object of increasing their crops.

It is advisable to distribute the hives rather than to have them all in one spot, the ideal arrangement being one hive to each acre of fruit.

It may be found practicable to take hives to fruit plantations just before blossoming time, and afterwards to remove them to where there is more diversity of flowers, in the same way that hives of bees are taken to the heather moors. I have for three years taken out a hive to a cherry orchard just before blossoming time, and brought it home after flowering was over, with satisfactory results.

It is said that bees fly from their hives against the direction of the wind and have it with them when returning laden with pollen and nectar, so that it may be advisable for hives to face the direction of the prevailing wind.

It is important to have the bees in the hive strong and in large numbers ready for their work in the early spring, the bees should, therefore, be left with sufficient food in the autumn for the winter, and will be benefited by being given syrup in early spring.

There are three ways of managing the bees on a fruit farm :— (1) For the owner to look after them ; he may not have time or may not like bees, so (2) he can get one of his men to look after them, giving him a little higher wage ; (3) he can allow a bee-keeper to keep his hives in his orchards or even pay him, say, 5s. a hive, for the use of his bees for his fruit.

I asked Messrs. Chivers & Sons, of Histon, Cambridge, their opinion about bees, and Mr. H. J. Chivers very kindly replied : " I am afraid that, unlike our American friends, we are unable to state very definitely the effect of bees on the pollination of fruit. To our minds, it entirely depends on the type of weather just before and during the flowering of the fruit as to whether the bees are actually a great deal of good or not. However, as we keep about 500 stocks of bees, you will realise that we do believe in them."

Conclusion.

To summarise this paper, the points I wish to emphasise are, that if there are not sufficient wild insects, especially bumble bees and the small wild bees, in the neighbourhood to pollinate the crop efficiently, persuade someone to bring his hives of bees to your plantation and have the honey he gets as his reward.

2. In planting a plantation or orchard of fruit trees choose two or more varieties that flower about the same time, avoiding planting together varieties of cherries that are inter-sterile.

3. Where trees of one variety have been planted in large numbers inter-plant or re-graft one tree in nine with another variety in order to get cross-pollination.

Finally, I have to thank Mr. F. I. Neame and Mr. H. Stevens for allowing me the run of their farms in which to make experiments, and answering many questions, also Mr. H. S. Rivers and Mr. E. A. Bunyard for making records of the order of flowering ; I thank Mr. F. J. Chittenden, Director of and Mr. A. N. Rawes, Experimenter of the Royal Horticultural Society's Gardens, also Mr. M. B. Crane for much of the information included in this paper, also Mr. F. Edenden, of Wye, who made most of the lantern slides.

DISCUSSION.

The Chairman, in opening the discussion, remarked that the side of the subject in which he had been more particularly interested was that of the effect of the weather on the growing of fruit ; and illustrated his remarks by means of a lantern slide of a pear blossom, showing how unfavourable weather adversely affected the germination and growth of the pollen grain.

Mr. G. Fox Wilson (Royal Horticultural Society's Laboratory, Wisley) said he was particularly interested in the paper from an entomological point of view, as there had been carried out at Wisley for some years close observations on the insect visitors to fruit flowers. Wisley was surrounded by a good deal of wild country, and it had been found that hive bees had played very little part in the pollination of the fruit trees there. In 1919 and 1920, when detailed observations were first commenced, hive bees had been entirely absent, yet during those years excellent crops of apples, pears and plums had been obtained, due wholly to wild insects, particularly humble bees. In 1921 hive bees were present in quantity, but during bad weather, cold winds and heavy rains they had not worked; whereas he had found the humble bees working extremely industriously. In the same year he had paid a visit to a very large fruit farm in Essex on a pouring wet day. He had been on the fruit farm from 10 a.m. to 4 p.m., during which time it had never stopped raining, and there had not been a single hive bee about; but he had seen humble bees busily engaged in pollinating flowers. He did not want to minimise the importance of hive bees, but it should be realised that in certain localities in which some fruit farms were placed, such as Wisley, the work depended mainly or entirely on humble bees, and other wild bees and certain flies. In the case of pears, blue-bottles were extremely useful.

The Chairman remarked that he wondered what the country would be like if everybody propagated the humble bee in all the fruit plantations. He was glad to hear Mr. Fox Wilson say a good word for blue-bottles. It was the only time he had ever heard any good of them. Mr. Grainger was present—a gentleman who always managed to get regular crops of Cox's Pippins—and perhaps Mr. Grainger would tell the audience how he did so.

Mr. H. Grainger said he could not say a great deal on the matter of how he managed to obtain regular crops of Cox's Pippins. The longer he went on, the more he felt that he could not express an opinion as to how things did come about. For instance, in 1917 there had not been a hive of bees anywhere in Essex, and yet it had been one of the biggest fruit years, with the finest sets he had ever seen. He had been very interested in what the Chairman had said about the weather, because personally he thought that had a great deal to do with the matter. In 1918, for example, there had been very few apples about. Owing, no doubt, to the dull, moist weather, there had been no circulation of the pollen. One important matter to pay attention to was the health of the tree. The healthier a tree was the better the set, and the better the distribution of the pollen. He had not noticed that fact until the last year or two, when he had some trees which were not so healthy as they should have been. Those trees had a good deal of bloom, but very few sets at the finish; and he was inclined to think that their less healthy condition had a good deal to do with it. It was true that he had had good crops of Cox's Pippins year after year. In 1920, for instance, he had a good crop, although no other variety was in flower until after Cox's; even Worcester (which is supposed to be helpful), had not come into bloom; this result had puzzled him much and he could not understand it.

Mr. W. Rogers (Past Chairman, East Malling Research Station) agreed with Mr. Grainger that the health of the tree had a great deal to do with the cropping of it, but he thought there was a gentleman who had also a great deal to do with the cropping of the fruit tree, and that was Mr. Jack Frost. With the weather conditions good, one generally got a crop. He himself had been favoured with a

good crop of Cox's Pippins in 1918, but he was bound to say that since then his Cox's had been very shy. He could not say why, because they were planted in amongst Worcester Pearmains, and other varieties, which were supposed to be suitable. Certainly he should say, as a practical fruit grower, that while the Bramley Seedling or the Newton Wonder would buy the horse, the Cox would not buy the bridle. In relation to cherries, he knew of a large orchard of very well-grown trees planted a number of years ago at Kingsdown, which very rarely grew a crop of cherries. He had been speaking to the present tenant lately, who said that he found by inter-planting he was gradually getting small crops there ; but it was really a tragedy to see those beautiful trees growing and blossoming profusely, but with no result. That plantation was in one of the coldest districts in Kent, and he thought Mr. Jack Frost had stepped in there. He agreed with the Chairman that weather conditions had an enormous influence on the cropping or otherwise of the fruit. He would like to ask the lecturer the variety he thought was best to inter-plant with Doyenne du Comice. He had a row of Doyenne du Comice which made a very handsome picture, but whose fruit-bearing qualities were almost nil.

Mr. Spencer Mount said he had quite an open mind on the question of planting different varieties together. It was a matter which had rather worried him once or twice. He agreed with Mr. Grainger that a lot depended on the vigour of the tree and on the vigour of the fruit bud at the time of flowering. He had experimented once with some apple trees of the variety of Bramleys, Beauty of Bath and Gladstone—which one would say were not self-fertile varieties. He had cut those trees down very hard. He had cut more than half the wood off, and more than half of the fruit buds. When they had come into flower, the flower had been very bold on all of those trees, and it was a most remarkable thing that without exception every flower on all three varieties had set. There had been five Bramleys in a clump, five Beauty of Baths in a clump and five Gladstones in a clump—an occurrence which one never came across ordinarily in trees. It had struck him that it was not so much the cross pollination of different varieties, as the vigour of the fruit bud. By cutting the trees down by half, more vigour went into the fruit buds which were left. He had been on Mr. Grainger's plantations where the trees were very healthy. Mr. Grainger pruned them hard every year, and no doubt all his buds were very healthy, the result being a crop every year.

Mr. A. H. Hoare tendered his thanks to the author, with whom he had frequently corresponded, and whose letters had always been very helpful. He was very grateful, as he was sure every fruit-grower was, for the work which the lecturer had done and was doing. While pollination was an important factor in fruit production, it was not the only factor. Nutrition was another very important factor. A tree might become so starved that it was unable to develop the crop of fruit which it was called upon to bear. It might carry a good crop of leaves and blossoms, but the amount of favourable food in the soil might be so scanty that it was unable to produce the crop of fruit which, other things being equal, it would have produced. Another factor of importance was that of disease. That was equally as important as nutrition. They had recently taken some evidence in Cambridge bearing on the health side of the question, and it had been shown that repeated doses of a disease on an apple tree would throw it out of bearing altogether. Results had been taken over a number of years, and a stage had been reached where the control trees repeatedly attacked by apple scab had been

unable to bear fruit; whereas those trees which had been sprayed, and where attempts had been made to control the disease, were producing a crop yielding a profit of £50 per acre. That was one of the most important discoveries of recent years in the matter of fruit production. Everyone knew that Jack Frost was a very important gentleman. Mr. Grainger had referred to a point which might leave one or two rather mystified, and that was how he produced Cox's Orange Pippins in a year when there had been apparently no pollen about to produce cross pollination. He desired to mention the following point as bearing on that. There was a young scientist at Cambridge who was also an amateur aviator. He had been going up in an aeroplane several thousand feet, and exposing gelatine plates in order to see what he could find in the way of germs of disease or anything living, and he was producing some very interesting information. For instance, he had exposed gelatine plates several thousand feet above terra firma, and he had obtained pollen of all sorts, which showed how far these minute grains of pollen might be scattered by the wind. All fruit trees were wind pollinated as well as insect pollinated. Grains of pollen would sweep through the atmosphere probably for miles if the wind was favourable, and that was what he thought had really happened in such a case referred to by Mr. Grainger.

The Lecturer, in reply to Mr. Rogers, said he could only say what he had found successful with cross pollinating Doyenne du Comice. He had tried various different kinds of pollen, and the ones which he had found most successful were Hessle, Fertility and Triomphe de Vienne. He knew of cases, also, in which Glou Morceau had been found good by some growers.

With regard to bees, there was one small point he would like to mention, and that was that if the hives were actually on the spot the bees were ready to come out at a few moments' notice when the weather was fine; they were actually there on the ground to do their work. He had been very interested to hear Mr. Fox Wilson's remarks on that side of the question. Mr. Fox Wilson, however, dwelt in the midst of a beautiful district surrounded by moors, commons and woods, in which wild Nature was at its very best in the way of pollination. In many parts of Kent one found 50 or 60 acres of fruit where the woods and the banks had gone. He was absolutely certain that if one had a plantation of five acres of gooseberries, and one put down a hive in the middle, a heavier yield would be certain to be obtained, and the same with black currants. It depended on the balance of Nature to some extent.. He had been extremely interested at hearing about the young Cambridge scientist finding pollen grains in the air. That was well worth thinking over. It was very strange that the Americans had experimented on the transference of pollen by the air. They had taken off the petals from thousands of blossoms and had left them open to the transference of pollen by the air, and they had reported that there was not one case in 10,000 in which the fruit set; the insects did not go to the blossoms when the petals were off.

If anybody had any questions they would like to ask of him he would be only too glad to reply. His interest was to help fruit farmers. He would be only too pleased to try to solve any problem which was put to him. If only the practical man and the scientist would work together, in a very short time a great deal of information would be gathered together.

The Chairman, in proposing a hearty vote of thanks to the lecturer, said it was interesting to remember that Mr. George Norgate Hooper, the father of the lecturer, had been a Fellow of the Royal Society of Arts for nearly fifty years, and

had read several papers in that room. It was also interesting to note that the present lecturer had started work on the question of the pollination of fruit trees as early as 1908. He had been carrying on that work ever since, and those present were very much indebted to him for having come and given them an account of his original life work—certainly work which had extended over at least twenty years. If one looked at the tables which were exhibited on the wall, and if one studied the enormous amount of detailed observations which must have been made to get the exact dates of flowering of each of the varieties which had been mentioned that night, one would be able to gauge the enormous time and detailed work which the lecturer must have devoted to the subject ; yet he brought it all forward and laid it bare to the world in order that the fruit growers of the country might derive benefit from it. It was a very important subject, which had only just started to be tackled, involving at least three big sciences. The great amount of work which men like the lecturer were putting into it would rank as pioneer work, and he wanted the audience to join with him, for the reasons he had stated, in passing a very hearty vote of thanks to the lecturer for his excellent paper, and for the very interesting evening which he had given them.

The vote of thanks having been carried unanimously, the meeting terminated.

BRITISH INDUSTRIES FAIR.

British Industries Fair : White City.—Not only should we not be surprised, we should not be indignant, either, when a salesman says, pointing to some of his wares : " These are very beautiful ; we've been selling a lot of them lately." For this is the most respectable *non sequitur* of the present day. There is no doubt also a touch of up-to-date psychological science in the nonchalant assurance with which the salesman speaks ; he is bringing the pressure of suggestion to bear on his possible customer. " Forty million Britons can't be wrong," says a contemporary advertisement, so casting the lie in Ibsen's teeth ; for Ibsen said : " The minority is sometimes right : the majority is *always* wrong."

A salesman at the White City picked up a tea-cup to show me, of which the only beauty, and that only from his point of view, was its alleged popularity. The brim of this cup was so artfully twisted about that only somebody with a knack could hope to avoid spilling half the liquid contents when drinking. Every conceivable shape of pot, and every conceivable decorative design for pots was to be found at the White City—except some of the simpler and better ones in each case. If one had had to choose an ingenious and fantastic set, I should have given my vote for the work of an Irish firm, the Fermanagh Pottery Company, whose more delicate pieces have a pearl-like glaze inside. On the other hand, a good sensible line, I thought, was that displayed by the Pearl Pottery of Hanley ; simple shapes, a blue-grey colour—not unlike that of Messrs. Wedgewood's well-known lavender ware—and not too high a glaze.

The glass in general was inoffensive. One booth showed that the influence of Lalique has not been altogether rejected by British industry, but the designs themselves were very poor. Some large, round, painted flower bowls, exhibited by Messrs. Walsh of Birmingham were really attractive, and the glass fittings in the special section organised by the British Institute of Industrial Art were very satisfactory.

This special section was, as might have been expected, of great interest. The most discriminating foreign critic could not, if only on its account, have left the Fair with feeling anything but respect for our industrial art. Here, in some

sort of an *ensemble*, was arranged a selection of furnishing textiles, metal work, furniture and various accessories. The wrought-iron garden gate by the Stepney Craft School, an agreeable piece of work, acted as an entrance to one wing of this exhibition within the exhibition. The eye was then immediately caught by what is described as a "cast-iron mantel register gate," designed by Professor Lethaby. This had a fellow in the other wing, a slightly larger and equally fine grate, with architectural lines and a sober pattern. Here some curtains might be seen, designed by the most versatile of our men of taste, Mr. Roger Fry. The textiles were mostly good, both those which depended on their pattern and those which depended on their sheen. The furniture, too, was on a high level, though the simplicity in which the pottery was lacking is not by itself enough to be the making of a work of art where sideboards are concerned. Messrs. Russell, of Broadway, showed a civilised bedroom suite, and Messrs. Peter Jones a set of cane-bottomed chairs and a settee which would be excellent in the appropriate environment. A dining-room table was perhaps the best exhibit of the Bath Cabinet Makers, Ltd., and the walnut sideboard of this firm was almost very good.

If an office has got to be sleek and solid, and if someone in it has really got to do a great deal of work, the claims of the biggest table shown by Messrs. Globe-Wernicke should be very strong on the selector. This massive exhibit, the absolute antithesis in spirit of the Bureau du Roi and of the seventeenth and eighteenth centuries, recaptures in its proportions the humanity which it loses in its immaculate machine finish.

A small but interesting booth was that of Messrs. Myers, a London firm specialising in ivory goods. Just as the makers of Oxford Marmalade have proved that a jam-pot can have a good shape, so Messrs. Myers prove that a shaving brush or a manicure set in ivory can be satisfying without the least effort being made to allure the eye with frills. Their wares look as "high class" as they are described to be, and made the present reviewer's mouth water as much as anything at the White City.

Messrs. Ortweiler appear to have the same instinct for the intrinsic potentialities of leather that Messrs. Myers have for ivory. Their booth was not a booth, but an entire workshop, with large showrooms attached, yet in their range of exhibits one could not find much that seemed a mere concession to popular taste, or lack of taste.

The size of the Fair made it impossible for a short review to do more than touch on a few points. British toys are an interesting subject; the more elaborate ones are so good: could we not produce better simple ones? There is still more individuality in German toys than in ours.

In printing, too, we are behind the Germans: not, under the circumstances, that there is any disgrace in this. Perhaps the increasing interest in book production which may be diagnosed at home will gradually lead to our excellent typographers being given a freer hand by their chiefs. If we discourage them too much they will be off to the Continent or to America, whence they are certainly the recipients of tempting offers.

EXHIBITION OF ENGLISH DECORATIVE ART.

Loan Exhibition of English Decorative Art. Lansdowne House.—The setting in which so many treasures are exhibited is a splendid one, a mansion built by Robert Adam himself. The actual arranging has been done with great skill, but even these grand eighteenth century halls are overcrowded with such

a wealth of furniture, tapestry and silver. But with a little imagination it is possible to re sort the different pieces, and to construct in one's head several really " ideal homes."

The range of the exhibition is wide. The Guild Chair in Room I is mid-fifteenth century ; there is a tapestry panel in Room IX, lent by Her Majesty the Queen, which was woven for Queen Victoria about 1880. It is in tapestry that the show is most rich ; there is much fine silver, but not a correspondingly remarkable collection of furniture. Hepplewhite is not represented. Nor is all the late eighteenth century work as perfect as we might expect of the period ; on the other hand, some of the nineteenth century tables and chairs are charming. The wax flowers, No. 366, must not, indeed, cannot be missed, and visitors should not overlook the perpetual motion clock in the last room, which had just stopped, apparently for the tenth time that morning, as I was passing.

Sir Joshua Reynolds' portrait of Sterne looks down on what is one of the most attractive groupings of all. Two wool and silk panels, with a design of flowers and birds, woven in London about 1723, flank a gilt gesso table with cabriole legs dating from approximately the same time. The effect, heightened by a lovely bowl of tulips, is all one could desire : æsthetic, luxurious and reposeful. The red and orange needlework hanging, No. 212, is a copy of a tapestry of the same set as two panels mentioned above ; it has, however, a more emphatic character, and pleases in rather a different way.

No. 245 is as feminine as No. 212 is masculine ; it consists of embroidered bed curtains and valances, the designs in many coloured silks being on pink silk, and said to have been worked by Mary Blount, who married the ninth Duke of Norfolk in 1727.

For the grandest manner of all we must go back to those astonishing products of the Sheldon factory, called the Hatfield Seasons, Nos. 33 and 36, which were based on designs of the Fleming, Martin de Vos. It is interesting to compare them with work from the Royal factory at Mortlake, which was founded in 1620, nine years after the Hatfield Seasons were completed. No. 106, the " Miraculous Draught of Fishes," based on the cartoon by Raphael (secured by Charles I on the advice of Rubens), is a great contrast to the Sheldon tapestries. Aesthetically the latter could hardly be more satisfactory. The designs are closely knit and most skilfully distributed. They are in complete harmony with the texture of the material on which they are woven. A delightful, though less important pair of panels, Nos. 242 and 244, bear witness that a more sparse and intermittent pattern can be successful ; it is not, therefore, the size but the disposal of the masses in No. 106 which is not altogether agreeable. The historical importance of this piece is greater than its intrinsic beauty.

The cabinet makers of this country have produced few finer pieces than the satinwood commode, No. 277, " probably Chippendale," and the semi-circular cabinet in satinwood, tulip-wood and mahogany, by Sheraton, No. 319. The architectural quality of the former, the suavity and refinement of the latter are evident at a first glance ; yet they must be very pleasant to live with, and would doubtless improve on acquaintance. There is nothing forced or overloaded about such work, as in the case of much magnificent French furniture of the same period. The lines are simple, yet exquisite ; elegant, yet strong.

An agreeable example of primitive sophistication is No. 81, an Elizabethan four-poster bed in carved oak. Needlework hangings and a spread of a hundred years later have been added, and help to make a most attractive whole. The period of oak is also well illustrated by a cradle, a dining table, a court cupboard and an extremely fine chest, while many cushion covers, of just the right coarseness of

texture and niceness of design, suggest the robust culture of the early seventeenth century in England.

Many of the silver exhibits are of an impressive size; one could comfortably have a bath in one piece lent by the Duke of Portland. But there is dignity here, as well as bulk, and if it were not for the fact that demand for such goods is limited to-day, one would recommend the student of the craft to make careful notes of this section.

Among the curiosities are a pair of portraits: Collingwood by Nelson, and Nelson by Collingwood. The two admirals met at Antigua, and amused themselves in this very civilised way; nobody was ever less of the bluff bulldog than the most august of our national heroes. We know from his despatches that he was exceptionally broad-minded; we can see now that he knew how to use a pencil.

A general comment on the loan exhibition which may strike some modern designers as a little disingenuous is that it is a very human show. There are three courses before applied art to-day. Machines might be dispensed with as far as possible. This is not sensible or possible. Man might be further mechanised; his belongings might be clearer reflections of the machine age than they are. This is against reason and taste. Machines, on the other hand, might be humanised; used, that is to say, with greater discretion and individuality. This is the proper compromise. No great artist in any department of art has ever belittled the wisdom of the past; and because our English traditions are so valuable we must be grateful to all those who have lent their beautiful things for the public to see at Lansdowne House, and to Mr. Selfridge, for lending the house itself.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 11..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Wing-Commander G. B. Hynes, "Engine Performance Tests."

Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Mr. H. Keir Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.15 p.m. Mr. W. F. Ball, "Refrigeration as applied to Beer and Water Cooling and Cold Storage in Breweries."

Chadwick Lecture, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8 p.m. Mr. G. Mowlem Burt, "The Making of a Modern Building." (Bossom Gift Lecture.)

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Sir Walter Willson, "Europeans in India and the Reforms."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Mr. A. Broughton Edge, "Methods of Geophysical Exploration."

Heating and Ventilating Engineers, at the Borough Polytechnic, Southwark, S.E. 7.30 p.m. Mr. J. H. Bryant, "Sprinklers."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. C. H. Desch, "The Nature of Hardness." (Joint Meeting with Society of Chemical Industry.)

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. M. Parkin, "The Anodic Treatment of Aluminium for Corrosion."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. H. N. Gresley, "Rail Motor Car Developments."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture III.)

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Paul Vacher, "Present Aspects of French Politics." (Lecture IV.)

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C. 5.30 p.m. Prof. F. Fülleborn, "Some Questions of Tropical and Local Helminthology." (Lecture I.)

At University College, Gower Street, W.C. 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture II.)

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture V.)

5.30 p.m. Miss Edith C. Batho, "Scandinavian Influences in England since the 17th Century." (Lecture II.)

TUESDAY, MARCH 12..Electrical Engineers, Institution of, at the North British Station Hotel, Edinburgh. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Dr. E. V. Telter, "Merchant Ship Service Performance Analysis."

Mechanical Engineers, Institution of, at the National Oil Refineries, Skewen. 6.30 p.m. Mr. W. C. Mitchell, "Engineering Practice in Oilfields and Refineries."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Mr. G. Heseldin, "Drilling for Oil with a Diamond Drill."

Philosophical Studies, British Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. Sir Henry Slesser and Dr. C. Delisle Burns, "Church and State in Western Civilization."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Stanley W. Kemp, "Antarctic Whaling Expeditions."

Transport, Institute of, at 200, Buchanan Street, Glasgow. 7.30 p.m. Mr. J. Cuthbertson, "Canada and some of its Transport Problems."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture IX.)

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C. 5.30 p.m. Prof. F. Fülleborn, "Some Questions of Tropical and Local Helminothology." (Lecture II.)

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture I.)

WEDNESDAY, MARCH 13..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. C. Adams, "Bonding and Anchorage of Reinforcing Steel in Concrete."

Goldsmiths, Worshipful Company of, Goldsmiths Hall, E.C. Prof. R. Y. Gleadowe, "Line and Form in Silverwork and other Applied Arts."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Mechanical Engineers, Institution of, at the Grand Hotel, Sheffield. 7.30 p.m. Mr. A. P. Hague, "Alloy Steels at Ordinary and High Temperatures."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 12.30 p.m. Professor P. Saldau, "Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems." F. Hargreaves and R. J. Hills, "Work-Softening and a Theory of Intercrystalline Cohesion." G. B. Brook and G. H. Stott, "Note on the Testing of Electro-deposits on Aluminium." 2 p.m. to 4 p.m. Dr. P. J. Durrant, "The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold." Dr. Marie L. V. Gayler and G. D. Preston, "The Age-Hardening of some Aluminium Alloys." Clement Blazey, "Brittleness in Arsenical Copper—II." Dr. P. J. Durrant, "A Note on the Haughton-Hanson Thermostat. A Method of Fine Adjustment." Dr. W. Hume-Rothery and E. Rounsefell, "The System Magnesium-Zinc."

North-East Coast Institution of Engineers and Shipbuilders, at Belbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. M. Waters, "The Problem of High Voltage Measurement."

United Service Institution, Whitehall, S.W. 3 p.m. Mr. J. M. Keynes, "National Finance in War."

University of London, at King's College, Strand, W.C. 5.30 p.m. "The Social Background of History." (Lecture IX.) Mr. H. Avray Tipping, "The English Garden."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture IX.)

At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. W. S. M. Keighly, "Ledger Systems."

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C. 5.30 p.m. Prof. F. Fülleborn, "Some Questions of Tropical and Local Helminothology." (Lecture III.)

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist and Rydberg." (Lecture III.)

THURSDAY, MARCH 14..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. (1) Messrs. T. N. Riley and T. R. Scott, "Electrical Insulating Papers for the Manufacture of Power Cables." (2) Messrs. S. G. Brown and P. A. Sporing, "The Prevention of Ionisation in Impregnated Paper Dielectrics."

At University College, Dundee. 7.30 p.m. Mr. W. Woodiwiss, "Distribution."

Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. L. A. Robertson, "The Relations of William III with the Swiss Protestants (1689-1697)."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Percy Wells, "Pre-Tudor Houses and their Furnishings."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Mr. A. P. Hague, "Alloy Steels at Ordinary and High Temperatures." At the Engineers' Club, Manchester. 6.30 p.m. Dr. T. B. Morley and H. Pieling, "The Supermiser."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 1 p.m. H. C. Lancaster, "The Importance of Design, and Setting of Large Kettles used for Refining and Low Melting Point Alloys." Dr. W. Rosenhain and W. E. Prytherch, "An Improved Form of Electric Resistance Furnace." D. F. Campbell, "Recent Developments in Electric Furnaces." 2 p.m. to 4 p.m. C. Sykes, "Alloys of Zirconium—II." Dr. J. Newton Friend and W. E. Thorneycroft, "The Resistance of Zinc to Indentation (a Preliminary Account)." Dr. J. Newton Friend, "The Solution of Plain and Amalgamated Zincs in Electric Batteries." Dr. J. Newton Friend and W. E. Thorneycroft, "The Silver Contents of Specimens of Ancient and Medieval Lead."

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. (1) Dr. R. S. Morrell, "The Drying of Vegetable Oils." (2) Mr. R. G. Browning, "A Study of Whiting and Linseed Oil."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Annual General Meeting.

Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Paper on "Some Recent Developments in F.I.B. Research."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Handling and Interpretation of Metaphor."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture V.)

5.30 p.m. M. Marcu Beza, "Byzantine Influences on Roumanian Literature." (Lecture II.)

5.30 p.m. "Czechoslovakia." (Lecture IX.)—Mrs. Rosa Newmarch, "Modern Currents in Czechoslovak Music."

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture III.)

At University College, Gower Street, W.C. 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture III.)

FRIDAY, MARCH 15..Electrical Development Association, British, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. M. V. F. England, "Water Heating Developments."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Mr. W. Marston Acres, "The Bank of England."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Mr. J. Hamilton Gibson, "Mechanical and Transmission Losses in Marine Engines, Shafting and Propellers."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. V. M. Goldschmidt, "The Distribution of the Chemical Elements."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. John Middleton Murry, "Shakespeare's Dedication."

(King's College.) At 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture IV.)

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture IX.)

SATURDAY, MARCH 16..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. John E. S. Dallas, "Saxon Churches and their Remnants."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

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FRIDAY, MARCH 15th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 20th, at 8 p.m. (Ordinary Meeting.) PROFESSOR A. E. RICHARDSON, F.S.A., F.R.I.B.A., Professor of Architecture, University of London, "Modern English Architecture." THE RIGHT HON. LORD STANMORE, C.V.O., will preside.

SHAW LECTURES.

MONDAY, MARCH 4th, 1929. MR. BEN TILLET in the Chair. SIR THOMAS MORISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the last of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

On the motion of the Chairman, a vote of thanks was accorded to Sir Thomas Legge for his interesting and instructive course of lectures.

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 6th, 1929. MR. PERCY V. BRADSHAW, in the Chair.

A paper entitled "Commercial Art" was read by MR. TOM PURVIS. The paper and discussion will be published in the *Journal* on May 17th.

INDIAN SECTION.

FRIDAY, MARCH 8th, 1929. SIR EDWARD D. MACLAGAN, K.C.S.I., K.C.I.E., in the Chair.

A paper entitled "The Indian Peasant in History: an introduction to the Linlithgow Report," was read by MR. W. H. MORELAND, C.S.I., C.I.E., formerly Director of Land Records and Agriculture, United Provinces. The paper and discussion will be published in the *Journal* at an early date.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1929 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

1864. Sir Rowland Hill, K.C.B., F.R.S.

1865, His Imperial Majesty Napoleon III.

1866, Michael Faraday, D.C.L., F.R.S.

1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.

1868, Sir Joseph Whitworth, LL.D., F.R.S.

1869, Baron Justus von Liebig.

1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.

1871, Sir Henry Cole, K.C.B.

1872, Sir Henry Bessemer, F.R.S.

1873, Michel Eugene Chevreul, For. Memb. R.S.

1874, Sir C. W. Siemens, D.C.L., F.R.S.

1875, Michel Chevalier.

1876, Sir George B. Airy, K.C.B., F.R.S.

1877, Jean Baptiste Dumas, For. Memb. R.S.

1878, Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

1880, James Prescott Joule, LL.D., D.C.L., F.R.S.

1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

1882, Louis Pasteur.

1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

1884, Captain James Buchanan Eads.

1885, Sir Henry Doulton.

1886, Samuel Cunliffe Lister (afterwards Lord Masham).

1887, HER MAJESTY QUEEN VICTORIA

1888, Professor Hermann Louis Helmholtz.

1889, John Percy, LL.D., F.R.S.

1890, Sir William Henry Perkin, F.R.S.

1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

1892, Thomas Alva Edison.

1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

1894, Sir Joseph (afterwards Lord) Lister, F.R.S.

1895, Sir Isaac Lowthian Bell, Bt., F.R.S.

1896, Professor David Edward Hughes, F.R.S.

1897, George James Symons, F.R.S.

1898, Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

1899, Sir William Crookes, O.M., F.R.S.

1900, Henry Wilde, F.R.S.

1901, His Majesty King Edward VII.

1902, Professor Alexander Graham Bell.

1903, Sir Charles Augustus Hartley, K.C.M.G.

1904, Walter Crane.

1905, Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

1907, The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.

1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

1909, Sir Andrew Nobel, K.C.B., D.Sc., D.C.L., F.R.S.

1910, Madame Curie.

1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., F.R.S.

1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G. G.C.V.O., LL.D., D.C.L., F.R.S.

1913, His Majesty King George V.

1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.

1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.

1916, Professor Elias Metchnikoff.

1917, Orville Wright.

1918, Sir Richard Tetley Glazebrook, C.B., Sc.D., F.R.S.

1919, Sir Oliver Joseph Lodge, D.Sc., LL.D., F.R.S.

1920, Professor Albert Abraham Michelson, For. Memb. R.S.

1921, Professor John Ambrose Fleming, D.Sc., F.R.S.

1922, Sir Dugald Clerk, K.B.E., D.Sc., LL.D., F.R.S.

1923, Major-General Sir David Bruce, K.C.B., D.Sc., LL.D., F.R.C.P., F.R.S., and Colonel Sir Ronald Ross, K.C.B., K.C.M.G., D.Sc., LL.D., M.D., F.R.C.S., F.R.S.

1924, H.R.H. The Prince of Wales, K.G.

1925, Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., M.B., LL.D., F.R.S.

1926, Professor Paul Sabatier, Member of the Institute of France, For. Memb. R.S., Davy Medallist, and Nobel Prizeman.

1927, Sir Aston Webb, G.C.V.O., C.B., P.R.A., 1919-24, P.R.I.B.A., 1902-4, F.S.A., LL.D.

1928, Sir Ernest Rutherford, O.M., LL.D., D.Sc., F.R.S.

SIR E. DENISON ROSS'S CANTOR LECTURES.

Sir E. Denison Ross, who is travelling in the Near East, has been delayed by severe weather and will not be back in England in time to begin his course of Cantor Lectures on "Nomadic Movements in Asia" on April 15th, as previously announced. The first lecture will be given on April 22nd, and the three following lectures on April 29th, May 6th and 13th.

REPRINT OF CANTOR LECTURES.

The three Cantor Lectures on "Biology and Refrigeration" by Dr. Franklin Kidd, M.A., D.Sc., recently published in the *Journal*, have been reprinted in pamphlet form (price 2s. 6d.) and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can also be had on application.

FUND FOR THE PRESERVATION OF ANCIENT COTTAGES.

ANNUAL GENERAL MEETING.

WEDNESDAY, FEBRUARY 27TH, 1929.

THE RT. HON. J. RAMSAY MACDONALD, P.C., M.P., in the Chair.

THE CHAIRMAN:—I have been honoured by an invitation to preside over this meeting, and I accept it with the very greatest pleasure. The object of the meeting is to consider and adopt the Report* of the Fund for the preservation of ancient cottages. I think we can all join with great heartiness in congratulating those who have been responsible for the creation of this Fund. All sorts of things are preserved. We ourselves are preserved by our doctors, for good or for ill. Our pictures are being preserved, certainly for good; and we would wish that the operations and the power of such Societies as the National Art-Collections' Fund could be even stronger than they are now. Our large, important, conspicuous national buildings are preserved by various Societies and various authorities But, ladies and gentlemen, I feel that you all agree with me that those delightful but vanishing cottages scattered over our countryside, each in itself embodying the spirit of its district, should not be allowed to fall into decay, if joint and co-operative action can preserve them for posterity. I am not going to take up any of your time this afternoon in expanding or expounding that doctrine, because I have in front of me a considerable list of people whom I am sure you desire to hear but I should like to say this—that whilst we are all apt to measure progress by figures about this, and figures about that; by things like the cut of our coat compared with the cut of our grandfathers' or great-grandfathers' coats, none of those measures of progress really touch the heart and the soul of things. Unless we can manage, in a prosperous materialistic age, to keep standards of good taste standards of spiritual appreciation—those intangible standards which cannot be measured by weights or by rules, but which are things which relate to the spiritual qualities and appreciations - progress may be apparent on paper but it may be very sadly lacking in reality. What we find in our various pilgrimages in search of peace and happiness and beauty in our country, is that so many of our modern dwelling places are absolutely dead from their birth. We might call them stillborn They have never lived. They never express a warmth of heart. They have not that characteristic which, when we see them and approach them, seems to come and meet us halfway with welcoming and encircling arms. They never move towards us. We have to get up to them, and when we have got to them they have not a whisper of welcome to give to us. We enter their doors and we get no inspiration, no happiness, and no spiritual comfort from their companionship. Now these old cottages, scattered from one end of the country to the other, give one a spirit of companionship, co-operation and happiness. We must not allow those expressions of the home spirit of our ancestors to pass altogether out of our experience. We must not allow ourselves to be left with the dead bricks which serve no purpose except to afford us a shelter from the winter's cold and protection from the summer sun. That is not a house. That is a hutch, or something else of the same kind, something that we express by "it." There is no man who is

*The Report will be found printed on pages 459-470

happy, and there is no man who has a chance of developing really everything that is in himself, if his home appeals to him as being something of the neuter gender. It must be something that is part and parcel of his own individuality.

Of course, there are a great many issues involved in this. I can remember, and I think my friend Mr. Chesterton will certainly remember, that delightful and penetrating pamphlet by William Morris called "Useful Work versus Useless Toil." There are far too many of our homes built to-day, and being built, not by useful work but by useless toil. Therefore those of us who are here this afternoon, and those outside who share our sentiments in this respect, really are upholding an ideal, both artistic and moral, of work itself. The men who built these cottages never could have produced them if their muscles only had been exercised in their creation. They have been produced by a combination of muscular and heart service; and so long as we appreciate them, and so long as we vindicate their existence, and so long as we strive and toil for a continuance of their existence, whatever our intellectual convictions may be, our moral convictions must always predicate this—that heart and hand must go to the production of everything that enters as an element into home life.

There is one other observation I would venture to make, and claim your indulgence for making, before I ask Mr. Chesterton to follow me, and it is this As this nation grows older we will find more and more the necessity of keeping sanctuaries for the human foot and human mind. We talk about bird sanctuaries, sanctuaries for flora and sanctuaries for fauna. These are excellent. But are we going to forget the even greater necessity of maintaining sanctuaries for ourselves? And if the sanctuary which is to be preserved for human beings is to be as rich as it ought to be, and as it can be, it must have something in it which is human, something which expresses the joy, the adoration and the contentment of the striving and aspiring human soul. Therefore, there can be no sort of holy of holies in those sanctuaries better than the work of man's hands exerted for the purpose of building a home with results such as we see in some of the most beautiful, the quietest and the most reverent of these ancient cottages that unfortunately are so fast going to decay.

I am sure many of you have experienced the pleasure that I have had of a day when perhaps you have been trudging far and fast over delightfully inspiring moorland; and when the sun begins to set and the light from it is colouring with wonderful pathos the sky, you come to the bend when the road descends, and first of all you detect over the shoulder of a rising ground a blue smoke; and as you go down the winding road you are received, as it were, into the arms of a quiet peaceful settlement of thatched cottages. It seems as though somebody had been wandering and wandering and wandering for generation and generation and age and age, and had at last found rest in this little nook that had been waiting there for years and years to receive you as the only pilgrim.

We must not allow those places and those experiences to become absolutely impossible for our sons and our grandsons. I am not going only to appeal to you as men and women of taste, and men and women of good sentiment, but it is your duty as citizens, it is your duty as fathers and mothers, to see to it that those gloriously rich moments through which we have lived, those gloriously rich experiences that we have had at the end of those great days, shall still be a possibility to the young men and the young maidens who are going to fill our places when we are no longer here.

I, therefore, formally move that the Report should be adopted.

Mr. G. K. Chesterton:—Mr. Chairman, Ladies and Gentlemen. You, Sir, have said in a double sense, and with more truth than you knew, that in this matter I am to follow you. I do not think there is anything really which can be at all adequately added to what Mr. MacDonald has said so eloquently and so truly about the essential ethics and æsthetics of this question. I am driven back upon what is for me an incongruous and almost ghastly role, namely, that of attempting to be, in the presence of the distinguished leader of the Labour Party, a practical politician. At least, I am only going to say a few words on another aspect of the whole matter, because I feel that Mr. MacDonald has really said all that we want said upon the most serious aspect of it.

What is taking place in the countryside to-day is, to my mind, something more extraordinary than has ever happened in all the revolutions of the world. It is most extraordinary, because it is for the first time a revolution which is also a contradiction. It is like something out of *Alice in Wonderland*. It is a logical inconsistency incarnate, because what you see is that the country is being ruined by people who like the country. All sorts of wild and extraordinary movements and changes have passed across this planet in the course of history. But men were not spreading and destroying the religion of Mohammed at the same time. Men were not at once spreading the principles of the French Revolution, and also contradicting and denying them. There has been a great rush of men to build medieval cathedrals. There has been a great rush of men to destroy them and smash the images in them. God forbid that in this impartial atmosphere I should betray for a moment which of those two religious movements I consider the more valuable. Anyhow, it was not the same people who built the cathedrals and smashed the cathedrals. But it is the same people who pursue the country and ruin the country. You have perpetually a number of uninstructed, ill-educated, but rightly inspired people pouring out from the detestable industrial cities and trying to live something more like the ancient and healthy life of man, with the unfortunate result that they carry out with them all the most detestable characteristics of the detestable civilisation from which they flee. It is a comic, but also a tragic, and even a pathetic spectacle; and of course it is only too easy to be cheaply superior about it and to talk about the culture of Upper Tooting, and so on, spreading over the world. Personally, I do not mind what I call the culture of Tooting as long as it is unconscious and sincere. I prefer Lower Tooting to Upper Tooting. But it is the actual practical fact of the situation that when the people of Tooting rush out, let us say to anywhere you like—Tenbury or Tetbury, two places in the West Country which I always confuse together because I have a cousin living in each—when the inhabitants of Tooting rush out to Tetbury they immediately begin to try and make Tetbury or Tenbury, as the case may be, as much like Tooting as possible. That is the real tragedy and the real farce of the whole situation, and it is very difficult to say how it is to be stopped. There are two ends at which you can begin. If you are a great idealist and evangelist you can attempt the conversion of Tooting. If, on the other hand, you are a local patriot you can, of course, die defending the road to Tenbury or Tetbury. It is probable, I think, that the real solution of that problem, which is the root problem of the whole thing, lies in the fact of the neglect and decline of agriculture. When people lived in Tenbury and Tetbury, prosperously and privately, and when they had to live on the land and by the land, they built their own houses suitable to the land and to the landscape. But when people go there simply as tourists, as trippers, as horrible people seeing views or going to beauty spots, they lack that inner creative impulse out of the earth which makes man create anything which is in the image of its origin and its significance.

I remember, for instance, a friend of mine who lives in Sussex in an old house. It was originally quite a small cottage—I believe a village shop. It still has the sort of fossil remains of the counter and of the places where the grocer's goods were piled on shelves. I remember looking out of the window of that cottage and pointing out to my friend that the window formed an exact frame, like the frame of a picture in the Royal Academy (if in so artistic an assembly I may mention such a place!)—the window formed a frame for the low, largely-spreading branches of a tree immediately opposite. If you had painted that thing as a picture and designed it for a frame, you would have made the window in that way. And if you examined carefully, you saw that the whole character, not of Sussex, but of that particular corner of Sussex—which is a corner of heavy land with low-spreading trees, and not the high downs and the bare part of Sussex—you would see that the whole architecture of that little house, which was never intended for anything but a cottage or a shop, quite unconsciously followed the lines of the landscape. Had it been on the high downs above the sea, it would have been built differently. That is the art of architecture—the ancient and inspired art of a sort of frozen poetry in stone and clay—and people did it unconsciously, just as they sung songs unconsciously, just as they created great epics in the morning of the world unconsciously. We cannot do that now apparently. At any rate, we cannot do it until our society has been established on a considerably more healthy basis, particularly our agricultural civilisation; but we can say, if this wild, contradictory, extravagant movement is going on whereby people are perpetually destroying the very thing they seek, whereby people are to be perpetually rushing after a thing and killing it as they rush—we can at least say "Look here, here is a definite creation of man made under more normal, more dignified and more sane social conditions. It is like a Greek temple surviving in an age of barbarians. You shall not touch it. This belongs to the history of humanity. This is a human and a permanent thing. This was built by man for men living off the earth, as men have always lived and ought to live. It shall not be interfered with."

That, I take it, is the simple object of this Society. It is not, I take it, merely a Society of æsthetics. We are not running after beauty spots or pretty views. You defend the old cottage not because, viewed from a certain angle, somebody can make a beautiful water colour sketch of it, but because, as compared with a bungalow put up by a fool who spoils the very place that he admires, it is a sensible, solid, practical, utilitarian object. A man comes and builds a bungalow, another man comes and builds a bungalow at a totally different angle to it. A third man comes and builds another, and whole districts of the countryside are thus covered with a meaningless, criss-cross of lines which do not make a street or a village or a hamlet or any recognisable human thing: they make a litter.

In the midst of all these things stands the old human English cottage. God knows it had vices enough, and the system to which it belonged had vices enough. I for one have never defended the vices of the old English landlord system—no more than the Chairman would; but it was the creation of a living human historical thing. It was built by people who lived on the land for people who lived on the land, and whatever else is allowed to destroy it, it must not be destroyed by people who do not know what they themselves want, and who destroy what they themselves seek.

Sir Charles Wakefield, Bt., C.B.E.:—The privilege which has been accorded to me this afternoon reminds me that I had the pleasure of assisting at the birth of the Fund for the Preservation of Ancient Cottages. Sir Frank Baines, to whose

inspiration we owe so much, launched the idea at the meeting of the Royal Society of Arts over which I had the honour of presiding. From that small beginning arose a fund which has already more than justified its existence.

There is little that need be said by me after the eloquent speeches to which we have just listened on behalf of this work. I can assure you, as far as I am concerned, that it will continue to have my practical support. As one who loves the peaceful beauty of our countryside, I rejoice that an organised effort is now being made to preserve some of the humble but very real wayside beauty of our lanes and villages

I want particularly to commend both the aims of the work itself and the method which has been adopted in more than one case. The idea of advancing sufficient from the central fund to save by purchase some particularly choice old cottage, and then initiating a local effort to make a permanent endowment possible, is in my opinion most excellent. It gives permanent value to any monetary support which sympathisers are moved to give to the Fund. It is undoubtedly the right way to administer this Fund wherever circumstances make it possible. If those present this afternoon will only report this aspect of the Society's work to their business friends, I am sure they will obtain fresh support from those who like to see good work well and wisely done

MR. H. AVRAY TIPPING, F.S.A.: -Mr. Chairman, Ladies and Gentlemen. Certainly after such admirable speeches as have been made by Mr. MacDonald and Mr Chesterton I am not going in for the "useless toil" of making another speech. I merely want to make what I will call, and what I hope is, a practical suggestion. What ought to be our work after two years of pioneering? I think we ought to begin to work now in rather a larger manner. We are all under the influence nowadays of the word "big." Everything has to be done on a big scale mass production, huge combines and monstrous advertisements. It is quite true that what we are working for is not something big, but for the preservation of something that is little - the modest and charming homes of the working men of the England of the past. Yet, at the same time, living as we do in these days, I fancy that the infinitely little has got to lie side by side with the infinitely big. I do not think we shall be able to carry this movement very far unless we do something in rather a big manner. It is quite right to begin in a humble and small way, to feel our way, to gain experience, to till the ground intensively so that we may know thoroughly what we are doing. That is what we have been busy upon for two years now, and I am glad that the Chairman considers that we have laboured very well and successfully. Certainly we have learned a good deal if we have not done so very much. We have saved a row of cottages in Sussex. We are saving a still larger row of admirable cottages in Gloucestershire. That was a good thing to do, and has taught us not only to do it but how to do more beyond it. It has taught us that, without any very great plunging into our own somewhat modest capital as it is at present, we can interest neighbours and local bodies so that these cottages can be saved and maintained largely by local money and by local effort. That is excellent. The question is, have we not now to go further? Have we not now to tackle not so much the problem of a little strip of a village, but a complete and entire village? What I should like this scheme for the saving of old cottages to say is "We are determined to try our hands on a large scale; we are determined to try our hands on a complete village." That is a big thing to do. I hope, having reached the age of more than discretion, that I am not rash; and I hope when I ask you to make a plunge you will see that it is a plunge into prepared waters—waters that we have been preparing for the last two years

and of which we have experience. That we have gained experience, that we have now a reputation, is surely clear by the fact that for our Annual Meetings we can obtain as Chairmen Prime Ministers and ex-Prime Ministers. Surely that gives us the right to come forward and say " We have gained our experience. We have begun well. We wish to go forward to something larger." But I think unless we appeal to those on both sides of the Atlantic who are in the position to endow our efforts with adequate funds we shall not succeed. I should say " Be brave. Let us find one of these really delightful villages and do our duty by it." I believe if you purchased it you would get support on both sides of the Atlantic. I believe in that way, properly advertised—I hope with advertisements that will not be monstrous, but by means of some charming pamphlet in which are photographs of the existing delightful village whose charms are perhaps under the bushel, which are perhaps a little decayed but which are full of latent possibility for beauty—and if, in addition, you asked a competent artist, a man of feeling, to depict something of the appearance which that village would obtain under your hands—I think then you would get very large support. You would be able to show your supporters one of these perfect villages—one of these villages which appeal not merely to the æsthetic brain but to the plain man's heart. You will be able to show them that there are, and there will be for ourselves and for those after us, some small but charming earthly paradises.

Sir Arnold Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O.:—I have been asked, as a member of the Advisory Committee of this Fund, to say a few words in support of this motion, which has been proposed by Mr. Ramsay MacDonald with such sincerity and eloquence and supported by Mr. Chesterton with his accustomed humour and grace. In this matter, we are all Mr. Ramsay MacDonald's constituents; among the cottages we seek to preserve, is many " a low white house, where dwelt the South land man." I, who have carried " The Ballad of the White Horse " in my pocket all over South America, should have known Mr. Chesterton to be an ally even had he not spoken. Two years ago this Fund was launched, with the approbation of Thomas Hardy, with the support of Mr. Baldwin and with the endorsement of the Duke of Connaught. No words of mine are needed to commend a movement initiated under such auspices and backed with such authority, but as a lover of England, which I left when I was 18 and to which I have only recently returned, I appeal to all to make the existence of this Fund known, not only to residents, but to the visitor from English speaking lands whose piety brings him to our shore.

Whilst we take off our coat to the future, we must not forbear to raise our hat to the past—to show the public how they may best perform the latter duty is peculiarly the province of this Fund. Our cousins from overseas are wont to make a pilgrimage to the homes and graves of their forebears and to seek to learn something of their manner of life. In cottages, along our sequestered lanes, the visitor can see how his forefathers fared, and what they held dear: here he may reflect on the immense labour of past generations that has gone to make the countryside; here he may see " the rock from which we were hewn and the pit from which we were digged." Such visitors will not be backward in helping this Fund if the appeal should reach their ears.

If one thing more than another distinguishes the history of this country from that of others not so blessed as we, it is surely continuity of tradition and custom. Other countries change the external form of their institutions, but retain only too often much of the bad old spirit. Our way is to keep our outward forms, but to change, for the better, the spirit that informs them. In this perhaps lies our

strength, and here perhaps is the secret of our unity. The cottages which it is the object of this Fund to preserve are indispensable and essential links with the past. It has been my good fortune to travel in many countries, new as well as old, and no single thing has struck me more than the moral and spiritual handicap under which peoples labour who have no tangible memorials of earlier ages: Mr. Ramsay MacDonald was recently in the U.S.A. and will understand, as will many of you, what I mean. To conserve such links is not less incumbent on us than to preserve the written records of our race, for these ancient dwellings reflect the outlook of their owners, not less surely than the furniture and internal arrangements of a modern house reflect the taste of its occupants. For just as most of us can arrange the interior of our houses to suit ourselves, so did our forefathers with their own hands and to their own plans build these houses, on sites of their choosing, "to live in" as Bacon says, "not to look at."

It is an elementary principle of art that a building, the form of which expresses the manner of its construction, is greater and richer than a building which fails to do so. No class of human dwelling place so completely conforms to this principle as do these cottages. Their beauty is not skin-deep: it is in their bones: in each and all of them there is an obvious link between the form and the material.

We do not seek to create show-places or museums—dead shells abandoned by their inhabitants, or occupied by week-enders, the human equivalent of hermit-crabs. Our object is to secure that these cottages are in every respect as comfortable and sanitary as modern houses, and that they are tenanted by agricultural workers, than whom no one in England better deserves a good home or knows better how to use one. "The rolling English drunkard," says Mr. Chesterton, "made the rolling English road," but he was sober when he made the cottages which we seek to preserve. After all, it is from such homes that the vast majority of us come—not more than four or five generations back, and such homes saw the birth of our greatest men. Preserving them, whilst working in other directions for better housing, we may help to give effect to Milton's appeal 300 years ago to his countrymen:—

"Let not England forget her precedence of teaching nations how to live."

May I in conclusion be allowed to quote another of my favourite poets, T. E. Brown:—

Dear Countrymen, whate'er is left to us
Of Ancient heritage—
Of manners, speech, of humours, polity
The limited horizon of our stage—
Old love, hope, fear,
All this I fain would fix upon the page;
That so the coming age,
Lost in the Empire's mass,
Yet haply longing for their fathers, here
May see, as in a glass,
What they held dear—
May say, "'Twas thus and thus
They lived"; and, as the time-flood onward rolls,
Secure an anchor for their Keltic souls.

SIR FABIAN WARE, K.C.V.O., K.B.E., C.B., C.M.G.:—As I listened to Mr. Chesterton I felt that the only role which was left for me to fill—as he had taken that of the practical politician—was that of the practical man. I am afraid in the time at my disposal I shall not be able to fill that role very efficiently, but I just want to explain

to you why I have been asked to speak this afternoon. I am at present Chairman of the Gloucestershire Rural Preservation Committee, which is extremely interested in what you are doing with regard to Arlington Row. My Committee has not been able to take any active part in the work you are doing, and I want quite briefly to tell you why, because I think, as the practical man, that that has a real bearing on the admirable suggestion which was made by Mr. Tipping with regard to expanding your work to a whole village. The Gloucestershire Rural Preservation Committee, which is working in close association with the Council for the Preservation of Rural England, is engaged in a desperate fight against the invasion of the countryside by new and totally unsuitable houses. We have decided that that danger is so great and so pressing that we must concentrate on that and on that alone. We have deliberately come to the conclusion that we have no powers which enable us to prevent that invasion as we should wish to. I cannot in the short time at my disposal give you any idea of the rate of the progress in the erection of pink asbestos roofed bungalows, or as to how village after village has gone for the next generation, or how bits of unequalled beauty are still left, but with the tide of ugliness lapping at their very edge. In the presence of Mr. Ramsay MacDonald I want to say that that situation has arisen entirely inexcusably, because no Statesman in this country has had during the last fifteen years the determination to say to these people, "You shall not." They tell us that that is interfering with individual rights. I may go into a new store in one of the most beautiful parts of the Cotswolds, and after a certain hour I may shout until the red corrugated roof rattles asking for an ounce of tobacco, and the reply is "You shall not." If I ask that we may do something to prevent a similar building being erected, I am told that that is interfering with individual liberties. I was recently in Alsace—in that part of Alsace which had been in German occupation for forty years. It has now been handed back. I saw there the only villages which in my experience in any way correspond to our Cotswold villages, and I saw that they had been preserved by the Germans for forty years as beautiful as when they first took them over—not denying the need of progress, but adapted by the best architectural advice to the old and still beautiful villages. It is not a pleasant thought, ladies and gentlemen, that, but for the Grace of God, the Germans would now be preserving our Cotswold villages for us.

At present we can do little more than educate public opinion, as legal powers to do anything practical are wanting. We are, of course, busily searching into Acts of Parliament for an illusory solution of our difficulties with an optimism which neither Westminster nor Whitehall will discourage. Nevertheless, we know that we can get no further on that line until we force this Government or its successor to give us the powers we desire. Meanwhile you are doing something practical. You are actually preserving from destruction some of these beautiful cottages. I need say no more about them. Mr. Ramsay MacDonald has described them to you. I will only say this—that I do wish, before you carry out your greater scheme, which has my heartfelt sympathy and support, you will remember that as well as cottages there are beautiful barns in our Cotswold country. I ask you to remember, too, that within the last twelve months the stone tiles from two of those most beautiful barns have been removed to America to roof churches in Boston, and they have been replaced by red corrugated iron. The tragedy speaks for itself.

I want you to know that the Gloucestershire Rural Preservation Committee is heart and soul behind you in the campaign which you are carrying on. We hope that the fact that Mr. Ramsay MacDonald is in the Chair at this meeting will result in our being placed, by the bestowal of those powers which we mean to have,

in the position of giving you greater help by preventing that beautiful Arlington Row, when you have restored it, from being utterly spoiled by the setting being destroyed—as it would be by the erection of bungalows and scarlet villas around it.

One last word. We have in Gloucestershire some of the very best architects in England. You have chosen for the work you are carrying out one of the best of those architects, Mr. Norman Jewson. Your Committee knows with what loving care and devotion Mr. Norman Jewson is carrying out this work. I hope that it will never be able to be said that through lack of funds he was not allowed to make the job that he wishes to make of this undertaking which you have given him.

THE CHAIRMAN:—It is now my duty to put to you the resolution which I have moved—that you adopt the Report, which has been circulated, of the Fund for the Preservation of Ancient Cottages for this year.

The resolution was put and carried unanimously.

SIR GEORGE SUTTON, Bt. (Chairman of the Council):—Mr. Chairman, ladies and gentlemen, it is my pleasing duty to ask you to give a vote of thanks to Mr. Ramsay MacDonald for presiding here to-day—not only for presiding and carrying out the functions of the Chair, but for having given us such a beautiful address. We have been very fortunate to-day in all our speakers, especially in the Chairman. I do not think I exaggerate when I call Mr. Ramsay MacDonald's address a poem.

Before I put the vote of thanks there is just one thing I want to say, and I say it as Chairman of the Royal Society of Arts. We want more subscriptions given to this movement. We have done very well. You who read the Report will see that in two years a good deal of work has been done, and we have many subscribers. But there is nothing that can be done now in the world, it seems to me, without money. and we have got to get it. We cannot expect to find the money to compete with those people on the other side of the Atlantic who come here and buy many of the beautiful things we have here. If, however, we have a large number of subscribers, and if every subscriber becomes an active supporter of this movement we can do much. And it is not the Society's money only that aids the objects we have in view. Such is the case of Constable's Flatford Mill. I understand that those buildings were secured to the nation by the direct influence of this movement.

Ladies and gentlemen, the time is late and I will not detain you by saying some of the things I would like to say about this movement. I will merely ask you to pass a vote of thanks to Mr. Ramsay MacDonald for his kindness in giving us some of his precious time in order to preside here to-day.

The vote of thanks was put and carried unanimously.

THE CHAIRMAN:—I am very much obliged to you, ladies and gentlemen, for the way in which you have responded to Sir George Sutton's request. May I say that I would like very much if you would support the appeal of his for more money? It is money that makes the mare go. Fortunately or unfortunately, that is the fact, and I think this Fund ought to be supported even more liberally than it has been. Then might I ask you to help as much as you possibly can the sisterly effort which is now being made by showing those horrors which have taken place in our countryside by the photographic exhibition which is now open at the Royal Institute of British Architects in Conduit Street? We really must put our backs into this preservation if we are going to succeed, and I do hope by supporting this Fund by money and by patronising the admirable, but horrifying exhibition which I have mentioned, you will encourage the preservation of some of those delightful inheritances which we have had from our forebears in this country.

The meeting then terminated.

FUND FOR THE PRESERVATION OF ANCIENT COTTAGES.

FIRST ANNUAL REPORT.

Advisory Committee.

Nominated by the Council of the Royal Society of Arts.

*P. Morley Horder, Esq., F.S.A., *Chairman.*
*Sir George Sutton, Bt. (*Chairman of the Council*).
Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
*E. J. Horniman, Esq., J.P.
*James H. Hyde, Esq.
*Basil Oliver, Esq., F.R.I.B.A.
*Alfred H. Powell, Esq.
*H. Avray Tipping, Esq., F.S.A.
*Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O.

Nominated by other Bodies.

Ancient Monuments Society ...	John Swarbrick, Esq., F.R.I.B.A.
Association of Women House Property Managers	Miss A. Churton.
Auctioneers' and Estate Agents' Institute	Sir William Wells, F.S.A.
The Worshipful Company of Carpenters	H. Westbury Preston, Esq.
Commons and Footpaths Preservation Society	Stenton Covington, Esq.
Council for the Preservation of Rural England	E. Guy Dawber, Esq., A.R.A., P.P.R.I.B.A.
Country Gentlemen's Association, Ltd.	F. H. Purchas, Esq.
County Councils Association ...	Sir Henry Fairfax-Lucy, Bt.
Cyclists' Touring Club ...	G. Herbert Stancer, Esq.
English Speaking Union ...	Dr. J. F. Muirhead.
Folk Lore Society	Dr. M. Gaster.
Garden Cities and Town Planning Association	A. T. Pike, Esq.
Guild of St. George	A. Farquharson, Esq.
Homeland Association ...	Prescott Row, Esq.
Institution of Municipal and County Engineers	E. Willis, Esq.
Ministry of Health	*Raymond Unwin, Esq., F.R.I.B.A.

National Council of Social Service	A. C. RICHMOND, Esq.
National Gallery, Trafalgar Square	C. H. COLLINS BAKER, Esq.
National Trust	*NIGEL BOND, ESQ., O.B.E.
Royal Academy of Arts ...	Sir GILES GILBERT SCOTT, R.A., F.R.I.B.A.
Royal Archaeological Institute	WALTER H. GODFREY, Esq., F.S.A., F.R.I.B.A.
Royal Automobile Club ...	ARTHUR J. DAVIS, Esq., F.R.I.B.A.
Royal Historical Society ...	HAROLD SANDS, Esq., F.S.A.
Royal Institute of British Architects	OSWALD P. MILNE, Esq., F.R.I.B.A.
Royal Photographic Society ...	THOMAS H. B. SCOTT, Esq., F.R.P.S.
Rural Industries Bureau ...	Lieut.-Col. W. B. LITTLE, D.S.O., M.C.
Scapa Society	
Society for the Protection of Ancient Buildings	*A. R. POWYS, Esq.
Surveyors' Institution ...	PERCIVAL F. TUCKETT, Esq., F.S.I.
Town Planning Institute ...	E. G. ALLEN, Esq., F.R.I.B.A.
Victoria and Albert Museum ...	R. P. BEDFORD, Esq.

* Member of the Executive Committee. The Executive Committee was appointed at the first meeting of the Advisory Committee on June 15th, 1927.

The proposal to institute a Fund for the special purpose of preserving our ancient cottages was first put forward by Sir Frank Baines in a paper which he read before the Society on May 6th, 1926.* While there are various public bodies charged with the duty of looking after our Ancient Monuments, cathedrals, etc., the unfortunate cottage has been left to the mercy of chance, with the deplorable result that many of the most beautiful specimens have been allowed to disappear. The need of preserving those that remain is, therefore, all the greater. In the avalanche of sham-tiled bungalows and houses good neither to live in nor look on that has overwhelmed the country, it is essential that we should save as many as possible of those quiet, peaceful and harmonious cottage homes if we would preserve any vestige of what was once the charm of our English countryside.

The plea put forward by Sir Frank Baines was so convincing that the Council of the Royal Society of Arts at once decided to adopt his suggestion. Accordingly a conference was called on January 26th, 1927, when the Prime Minister presided, and moved the following resolution :—

> "That this meeting, called to consider the best means of preserving the ancient cottage architecture of this country, declares its warm support of the movement started by the Royal Society of Arts, and signifies its intention

* Copies of the paper, which was printed in the *Journal of the Royal Society of Arts* June 11th, 1926, can be obtained on application to the Secretary.

to assist in the establishment of a substantial fund for application on the broadest national lines in furtherance of this movement."

The resolution was supported by the Earl of Crawford, the Speaker of the House of Commons, and Sir Alfred Mond (now Lord Melchett), and was unanimously adopted. At the close of the meeting it was reported that up to that date £1,855 had been promised.†

THE PRIME MINISTER'S APPEAL.

Shortly after the conference an illustrated pamphlet was issued containing an appeal on behalf of the Fund by the Prime Minister, and a note by the late Thomas Hardy. About 12,000 copies of this have been circulated, and very wide publicity has been given both to the conference and the pamphlet by the Press, to whom the Council and all those concerned in promoting the movement desire to express their grateful acknowledgments.

LUNCHEON AT THE CARPENTERS' HALL.

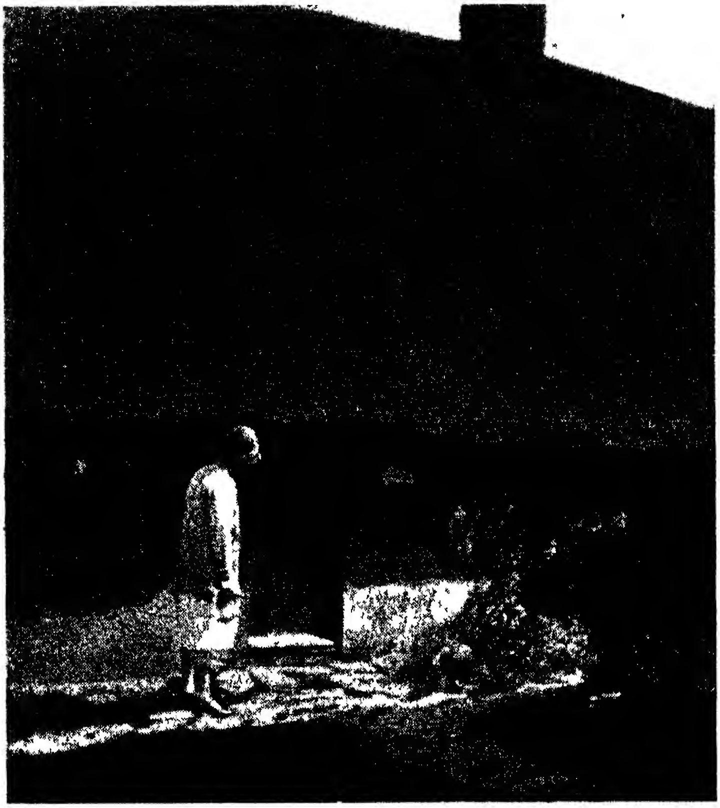
On March 25th, 1927, a luncheon in aid of the Fund was given by the Master and Wardens of the Worshipful Company of Carpenters in their Hall in Throgmorton Avenue. MR. H. WESTBURY PRESTON, the Master, in proposing the toast of "Success to the Fund," said that the movement initiated by the Royal Society of Arts was specially welcomed by the Carpenters' Company, because the beautiful old cottages which they were trying to preserve were largely the work of carpenters. The toast, which was supported by SIR ROWLAND BLADES, Bt., M.P. (Lord Mayor of London), SIR WILLIAM PLENDER, Bt., G.B.E., LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., SIR HOWELL J. WILLIAMS, D.L., and SIR BANISTER FLETCHER, VICE-PRESIDENT, R.I.B.A., was replied to by SIR FRANK BAINES, K.C.V.O., C.B.E. At the conclusion of the proceedings, SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, expressed the thanks of the Royal Society of Arts to the Master and Wardens of the Worshipful Company of Carpenters for the valuable support which they were giving to the movement.

As a result of the luncheon the sum of £949 14 6 has been contributed to the Fund through the Carpenters' Company.

APPOINTMENT OF ADVISORY AND EXECUTIVE COMMITTEES.

In February, 1927, the Council decided to appoint a large Advisory Committee containing representatives of the principal institutions and societies likely to be interested in the objects of the Fund, and a smaller Executive Committee. A list of these is printed at the head of this report. The Advisory Committee met for the first time in June, 1927, and the Executive Committee has met at fairly frequent intervals since then.

† A full report of the meeting was published in the *Journal of the Royal Society of Arts*, February 11th, 1927. Copies can be obtained from the Secretary.



CHARLES LAMB'S COTTAGE, "BUTTONSNAP"
Recently handed over to the Society

WORK DONE

Charles Lamb's Cottage

Shortly after the publication of the Prime Minister's Appeal, Mrs. M. Greg, of Coles, Buntingford, Herts., offered to hand over to the Society the cottage known as " Buttonsnap," West Mill Green, which was at one time the property of Charles Lamb

The cottage is referred to in Elia's Essay, " My First Play," in these words :

" F. (my godfather) was the most gentlemanly of oilmen . . . . . by his testamentary beneficence I came into possession of the only landed property which I could ever call my own—situate near the road-way village of pleasant Puckeridge, in Hertfordshire. When I journeyed down to take possession, and planted my foot on my own ground, the stately habits of the donor descended upon me, and I strode (shall I confess the vanity ?) with larger paces over my allotment of three-quarters of an acre, with its commodious mansion in the midst, with the feeling of an English freeholder that all betwixt sky

and centre was my own. The estate has passed into more prudent hands, and nothing but an agrarian can restore it."

The "commodious mansion" was a four-roomed cottage, and the door is so low that one has to duck one's head as one enters it. Local tradition has it that the name of the cottage, "Buttonsnap," is due to the fact that people, taken by surprise, duck so suddenly that the buttons snap from their trousers; but the etymologists may have something to say to this.

The cottage passed out of Lamb's possession in 1815, when he wrote to his tenant, Mr. William Sargus, as follows:—

MR. SARGUS,

This is to give you notice that I have parted with the cottage to Mr. Grig, jun., to whom you will pay rent from Michaelmas last. The rent that was due at Michaelmas I do not wish you to pay me. I forgive it you, as you may have been at some expences in repairs.

Yours,

CH. LAMB.

Inner Temple Lane,
London.
23 Feb., 1815.

The cottage is of a type very common in Hertfordshire and does not possess any special features of architectural or antiquarian interest; but in view of its association with the gentle Elia, the Council decided to accept Mrs. Greg's offer, and a small local committee has been formed under the chairmanship of Sir Arnold Wilson, who are charged with the duty of looking after the property. The cottage has been put into a good state of repair, and has been leased for a period of years to reliable tenants who are under obligation to maintain it and its surroundings in a proper state of preservation.

THOMAS À BECKET COTTAGES, WEST TARRING.

In September, 1927, the three well-known Thomas à Becket Cottages at West Tarring, near Worthing, were put up to auction. Shortly before the sale it was ascertained that attempts to buy the cottages would be made by two bidders, one with a view to demolishing them for the material which they contained, the other with a view to fitting them with modern plate-glass shop-windows.

It hardly seems credible that schemes of this sort could have been contemplated. The cottages are of quite extraordinary beauty and interest. The roofs are covered with Horsham slabs, and these, together with the oak beams, are in perfect preservation. The interiors are also in an excellent state, and the whole group forms a unique example of early fifteenth-century architecture.

Thanks to the intervention of Mr. A. Mackenzie Ross, who resides near Worthing, aided by an advance of £600 from the Society's Fund for the

THOMAS À BECKET COTTAGES, WEST TARRING.
Recently saved by the Society.

Preservation of Ancient Cottages, sufficient money was temporarily raised to buy in the property, which was secured for £950. A public meeting was called by the Mayor of Worthing on November 3rd; Sir Frank Baines delivered an address on cottage architecture, and it was decided to start a local fund. The cottages have been handed over to the Sussex Archæological Trust, who will maintain them as dwelling houses.

It is very satisfactory to be able to add that of the £600 advanced by the Society, £540 has already been repaid.

Arlington Row, Bibury.

At the close of 1927 the owner of Arlington Row, Bibury, finding that he was no longer able to keep the eight cottages in proper repair, offered to hand them over for a small figure to the Royal Society of Arts, on condition that they should be put into proper order, that the rents should not be raised nor the present tenants disturbed. Bibury is one of the best known villages in the Cotswolds, and Arlington Row is perhaps the most beautiful group of cottages in Bibury, and the Committee, therefore, requested their architect, Mr. Norman Jewson, of Cirencester, to examine and report on the condition of the houses. The beautiful stone-slated roofs are in imminent danger of collapse and other repairs are necessary, the cost of which is estimated at

£1,000. As the rents are insufficient to defray the cost of maintenance it was thought advisable to aim at inaugurating a special fund of £500 for this purpose, and an appeal was issued in March last asking for £2,000, which will provide for the purchase of the eight cottages, the repairs immediately necessary, and also for a permanent repair fund. The Appeal was signed by Earl Beauchamp (Lord Lieutenant of the County of Gloucester), the Bishop of Gloucester, Earl Bathurst, Sir Gilbert Wills, Mr. Walter Tapper (President, Royal Institute of British Architects), Sir Philip Magnus (Chairman, Council of the Royal Society of Arts) and Sir Frank Baines (Chairman of the Fund for the Preservation of Ancient Cottages).

In response to this appeal the sum of £1,275 19s. 4d. has been received. Although this falls considerably short of the sum aimed at, the Council have decided to purchase the cottages and carry out the necessary repairs. In the meantime the subscription list remains open.

Smarden, Kent.

In August, 1927, the Society's attention was drawn to the sale of property at Smarden in Kent, and especially to a very authentic half-timbered house which was so typical of the period that rumours of its purchase for deportation were confirmed. A question was asked in the House of Commons by Sir Leslie Scott regarding this. The Society has watched this carefully and it hopes to report very shortly that it has been preserved and that the purchaser will place himself in the hands of the Society to advise as to its restoration.

Other Cases.

In addition to the cases already mentioned, a great many applications have been received from the owners of cottages for assistance to enable them to carry out necessary repairs which they themselves are unable to afford. When the Fund was started the Committee were hopeful that they might be able to consider such cases, as they would have liked to save every cottage with any pretence to interest or beauty; but it soon became evident that the state of the Fund would not permit them to indulge in wholesale preservation, and they came to the conclusion that it was advisable to concentrate their efforts on preserving specimens of outstanding merit. They would like to take this opportunity of stating, however, that their first year's experience shows that they could with advantage spend a hundred times the amount that has been placed at their disposal, and in this way they would not only be doing a great deal to preserve the beauty of the countryside, but they would be making a sound and lasting contribution to the solving of the housing problem.

The Society has before it proposals to assist in preserving interesting cottages in Stroud, Glos.; Suffolk; Kent; Hampshire and Oxfordshire. It was also approached by the Medical Officer of Health at Shrewsbury regarding a

[Photograph by W. Dennis Moss, Cirencester

ARLINGTON ROW, BIBURY, GLOS.

considerable number of half-timbered cottages, which it was suggested were too derelict to remodel and which would in the ordinary course of things be condemned. The Chairman has visited the district and is dealing with a number of these and has advised that if certain works were undertaken they would make better and more roomy cottages than new ones, and that it is obviously in the interests of the district to keep these in existence. The attitude of the District Council of Shrewsbury is very encouraging and the Society felt it was its duty to give every possible assistance in the way of advice and is awaiting the development here with great interest.

The Society wishes to make it very clear that whilst it is anxious to preserve every bit of old beauty religiously, it realises that many old cottages have become so decrepit that it would be useless to keep them unless they can be made really healthy dwellings and unless the lighting, air content and sanitation can be made to conform to modern hygienic requirements for the men, women and children of to-day.

The building and planning of new houses and new residential areas is beyond the scope of the Society, but it is most anxious to encourage in any way possible the building of good new houses at rents which it is within the power of agricultural labourers to pay, and although opposed to riband development and ill-considered building schemes that conflict unnecessarily with the amenities of the countryside, it is far from desiring to oppose any housing schemes which are undertaken in the interests of public health and national welfare.

Flatford Mill and Willy Lott's Cottage.

Flatford Mill and Willy Lott's Cottage are indissolubly associated with the life and work of John Constable. In deference to the wish of his father he endeavoured to become a miller, and when about 18 years of age he spent some twelve months in the mill, trying to follow this trade. Fortunately for English art, however, his love of painting was irresistible and he went to London to study art; but throughout his life he remained devotedly attached to his native district; he returned repeatedly to Flatford, and the mill and its neighbourhood form the subjects of three or four of his most famous masterpieces.

In order to preserve this corner of Suffolk, hallowed by its association with one of the greatest of our landscape painters, Mr. T. R. Parkington, of Ipswich, has purchased Flatford Mill, the Mill House, and Willy Lott's Cottage. The property had fallen into extreme neglect, and Mr. Parkington, with the help and assistance of local antiquaries and others interested in the preservation of our cottage architecture, has carried out, at his own expense, the complete and adequate renovation and repair of the property. It may be interesting to mention that Mr. Parkington's action was the direct outcome of his hearing the appeal made by the Prime Minister in support of the movement at the Conference held at the Society's House on January 26th, 1927.

It is intended to use the property as a place of residence where artists may study landscape painting or to which art masters may take their pupils for holiday courses. The district abounds in interesting architecture, a number of the churches in the neighbourhood being particularly fine, and it is thought that students of architecture also could make it a centre of study.

Mr. Parkington has provided the place with appropriate furniture, and eventually about twenty bedrooms will be available for visitors.

The Possibility of Preserving a Complete Village of Exceptional Historic or Aesthetic Importance.

As a result of certain propaganda work undertaken by the Fund in the United States, and owing to various suggestions conveyed to members of the Committee by interested Americans, the Executive Committee is making an investigation into the possibility of considering the preservation of a complete English village of historic and æsthetic importance, which has fallen into neglect and decay. More than one village presents itself as suitable for a special undertaking, and the matter is under careful enquiry, with a view to seeing whether any developments are possible on these lines.

Photography Competition.

The Royal Photographic Society has shown a great interest in the propaganda work of our Fund, and in the February number of that Journal they made an appeal for good photographs of cottage architecture to all members of the Royal Photographic Society and to the many thousands of photographers throughout the country who are members either of photographic clubs or local photographic societies affiliated to the Royal Photographic Society. They also organised a photography competition, the subject of the competition being the interiors and exteriors of cottages. The photographs were exhibited in the Gallery of the Royal Photographic Society, and any photographs submitted may, under the conditions of the competition, be retained for the purposes of the Fund. The Executive Committee expressed their grateful thanks to the Royal Photographic Society for the interest and the valuable assistance which they gave to the movement.

Publication of a Book on Cottages.

As a result of an enquiry on the part of certain members of the Executive Committee discussions have taken place with a well-known firm of publishers as to the possibility of bringing out a comprehensive volume dealing with ancient cottages from the structural, historical and æsthetic sides. After considerable discussion it has been decided that Mr. Basil Oliver, a member of the Committee, who has previously shown his interest and enthusiasm in, and knowledge of, the Cottage Architecture of this country, should undertake the preparation of the volume, which it is hoped will be

published in the early future under the title of "The Cottages of England."* The thanks of all concerned are due to Mr. Basil Oliver for undertaking this important work, which will help in bringing the subject before the general public and be the means of initiating further propaganda work with regard to the general problem of the preservation of our ancient cottages. It is hoped that supporters of the Fund will do what they can to secure the success of the publication by bringing the volume to the attention of any persons who might be interested in the subject.

Meeting at the Carpenters' Hall.

With a view to making the movement better known The Worshipful Company of Carpenters invited the Members of the Society of Yorkshiremen in London to their Hall on March 31st, 1928, to hear a lecture by Sir Frank Baines, the guests being subsequently entertained to tea. The lecture was attended by a large audience. The Committee feel that the local patriotism in each county might be stimulated by lectures on the subject of local cottages, given in the large towns and illustrated by photographs. They would therefore welcome any suggestions for the giving of such lectures and would assist as far as possible in providing lecturers and slides.

Resignation of Sir Frank Baines.

The Committee have to record with deep regret that Sir Frank Baines has been compelled on the ground of ill-health to resign the chairmanship of the Advisory and Executive Committees. Sir Frank originated the movement, and he threw himself into it with his customary whole-hearted vigour, and it is only on account of imperative medical orders that he has consented to give up the office.

Mr. P. Morley Horder, F.S.A., has been elected Chairman in his place.

Finance.

Up to the present moment the amount subscribed to the General Fund for the Preservation of Ancient Cottages is £5,414 9s. 2d., of which £64 10s. represents annual subscriptions, which are particularly welcome.

The Committee were extremely anxious to establish an invested fund in order that the movement for the Preservation of Ancient Cottages should be a permanent one. At the same time they felt that the public were more likely to support them if they saw some actual results, and it was, therefore, decided to invest £3,000, and keep the remainder in a fluid form so as to be available in case any particularly interesting or beautiful cottages should be suddenly threatened. In this way they were able to save the West Tarring Cottages, which otherwise would have been demolished. The Society advanced £600 towards their purchase, and the committee in charge of them have, as stated above, already repaid £540 of this.

*See the descriptive folder which has been inserted in the Report.

In the case of Arlington Row, Bibury, it was decided to issue a special appeal for £2,000. The group of cottages is exceedingly well known. Bibury, which has been described by William Morris as "the loveliest village in England," is a show place, and the Committee felt certain that if it were known to be in danger, the public would be willing to subscribe the small amount that is necessary to save it.

The Royal Society of Arts have placed their office and staff at the service of the Fund, so that, apart from a small sum for extra clerical assistance, there have been no overhead charges.

OFFER FROM AN ANONYMOUS DONOR.

The Committee wish to invite attention to an offer which has recently been received from an anonymous benefactor, who has already contributed £500 to the Fund, to make a further contribution of 10 per cent. of all additional sums which may be received between January 1st and 31st December, 1929, from those who have given to the Fund from its commencement up to the date of the First Annual Meeting.

The amount already received is £5,414 9s. 2d. so that the anonymous donor is willing to more than double his gift of £500, and is anxious for as many as possible to assist to raise the total to at least £10,000. The income derived from such an amount would permit of the work of the Fund being proceeded with to a modest extent with no expenditure of capital, except in special cases, but a much larger sum could be very usefully administered.

It is hoped that many of those who have already subscribed may be willing to increase or double their contributions, in order to enable the Fund to reap the greatest possible benefit from this generous offer.

Contributions, which should be made payable to the Royal Society of Arts, and crossed "Messrs. Coutts & Co., Fund for the Preservation of Ancient Cottages," should be addressed to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

FINANCIAL STATEMENT TO DECEMBER 31ST, 1928.

Expenditure.	£	s.	d.	*Receipts.*	£	s.	d.
Invested	3,000	0	0	Subscriptions* to General Fund	5,414	9	2
Loan to secure Thomas à Becket Cottages, near Worthing, £600 less £540 repaid	60	0	0	Interest on Investments ..	113	6	10
Printing, Postage, extra clerical work, etc. ..	405	11	10	Hampstead Garden Suburb Stock	55	0	0
Balance in hand	2,117	4	2				
	£5,582	16	0		£5,582	16	0

ARLINGTON ROW, BIBURY, FUND.

	£	s.	d.		£	s.	d.
Printing, Postage, etc. ..	11	2	6	Subscriptions*	1,175	19	4
Balance in hand	1,164	16	10				
	£1,175	19	4		£1,175	19	4

* The lists of subscriptions have been omitted from the *Journal* owing to lack of space, but are included in a separately printed edition of the Report which may be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

NOTES ON BOOKS.

Outlines of Paint Technology. Based on "Hurst's Painters' Colours, Oils, and Varnishes." By Noel Heaton. With frontispiece, and 109 illustrations in the text. London: Charles Griffin & Company, Limited. 24*s.* net.

Mr. Heaton had a difficult task in prospect when he undertook the modernisation of the seventh edition of the late Mr. Hurst's textbook, so as to make it quite satisfactorily representative of the almost overwhelming mass of new methods; and this without neglecting the old methods, which are still of high commercial importance. The problem has been solved by a careful re-writing of the old matter, so as to gain a maximum of space, and the result is a work which deals fully and satisfactorily with both old and new; this, moreover, without unduly increasing the size of the book.

In the first thirteen pages, after a concise but sufficiently illustrated account of scientific fundamentals relating to light and colour, there follows practical instruction as to instruments by which colour measurements can be made. We have, in the premier aspect, Mr. Guild's colorimeter (Fig. 4, p. 8) a delicate and complex construction from the optical workshops of Hilger, Ltd. This device gives a synoptical view of a coloured surface and its fundamentals, the author telling us that "the operator, looking through the telescope, sees the colour to be measured side by side with a patch of light composed of the three primaries." The operator can then adjust the mechanism "until the light matches the sample." This elaborate construction by Hilger, although ideal where proper laboratory care is available, must in many paint works be made to cede to a less complex device. First among these is the portable and convenient Tintometer of Lovibond, pp. 8-9, and Figs. 5-6, in which the observer gets a view of the colour to be measured and of a like tint as obtained by arranging standardised glass colour screens. Lovibond's tintometer has stood the test of about half a century in our workplaces, and it still leads. Next, on p. 10, we find descriptions of comparable devices by Ives, Bawtree and Jones; this last making the match with three wedge-like films of tinted gelatine. Finally, on p. 11, the old rub-down method on a glass plate or on a white surface is described, and we learn how to use this method to the best advantage; one aid being a standard lamp giving an approximate simulation of an average noontide daylight (Fig. 8, p. 12).

In like concise, lucid and systematic manner the author treats of all the various aspects of his subject; we can, however, do no more than glance at a few of the more important features.

A specially important chapter from the standpoint of recent progress is that on "Solvents and Plasticisers," pp. 231 to 266, and this chapter may be looked on as largely introductory to the immediately following chapter on "Resins, Gums, Waxes and Bitumens": these two chapters giving the leading new features in the chemistry of the subject. In the old aspects of oil painting we may almost say there was but one solvent, the distilled essential oil of turpentine, although chloroform, the head and type of the chlorinated solvents, was brought into use by artist-painters more than half a century ago for removing old paint from brushes. The author, on p. 255, mentions the use of chloroform for removing free sulphur from ultramarine or from cadmium sulphide.

Soon after acetylene became an industrial product (about 1895), its chlorinated derivatives were manufactured on a large scale, and these with ethers, ketones, hydrocarbons and alcohols, swell the long list of modern paint solvents.

Cellulose ester paints, p. 368, may be regarded as modern, full-bodied successors to the old attenuated collodions; a special nitro-cellulose giving low viscosity being used. In sequence to this class we have (p. 371) an interesting account of silica ester paints which contain an organic silicate, as, for example, ethyl silicate. This constituent gradually undergoes hydrolysis at the outer surface by the action of atmospheric moisture; a coating of silica comparable to agate or opal being the result.

We ought not to close our notice without brief mention of the notable and serviceable modernism of Mr. Heaton's work in the matter of mechanical appliances, as in Fig. 28, which occupies the whole of p. 47, and shows us the principle of the Raymond machine for simultaneous grinding and separation of the fine particles by air flotation; while the next page indicates all essential details. Present-day drying plant in its keenest aspects is illustrated and explained on pp. 58-61: the best physical conditions being that the damp substance shall be spread out or divided, kept in motion under controllable warmth, and all this *in vacuo*: conditions realised " when the vacuum chamber takes the form of a rotary drum." The white lead manufacture in its standard " Dutch method " of acetic corrosion, is illustrated and explained in its most recent features on pp. 64-80, and by Figs. 45 to 50. Perhaps the most notable feature is the last, a " carding machine " for lead, whereby the metallic lead is reduced to a condition comparable to carded wool, and so becomes eminently suited for uniform corrosion.

We are now less than half-way through the series of 109 illustrations, each one of which might be used as a text for comments: we, however, turn once more to p. 368, where the two concluding illustrations are to be found, aluminium churns, for use in preparing cellulose ester paints. Here is a book to be valued by all interested in the manufacture of paint.

ELEMENTS OF BOTANY. By Richard M. Holman and Wilfred W. Robbins. New York: John Willy and Sons, Inc. London: Chapman and Hall, Limited. 17*s*. 6*d*. net.

The authors are known as efficient University teachers in the United States and as having written various essays and treatises on botanical subjects. Here we have a joint effort to produce what is termed in the preface a book for " one semster " work in the high school or university. On this side of the Atlantic a " second step " or " student's compendium " would be a good description.

There are, we estimate, between 700 and 1,000 clearly defined line illustrations of botanical fundamentals, and a useful feature of the full and helpful 20-page index is that when a subject is illustrated an asterisk is printed alongside its page number in the index.

As an example of the admirable way in which the authors combine illustration and text, we suppose the book to be open at pp. 212-213. On the left-hand page, Fig. 132 shows us four illustrations of stages in multiplication, by cross fission, of the common green alga, often called " *Protococcus*," while on our right the multiplication of the more complex filamentous alga " *Ulothrix zonata* " is shown by the nine illustrations embodied in Fig. 133. Here two sequently numbered figures embody thirteen illustrations; hence our uncertainty in estimating the total contained in the book.

From all standpoints the book is satisfactory, and it is a definitely valuable addition to the resources of the student.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock.

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., Professor of Architecture, University of London, "Modern English Architecture." THE RIGHT HON. LORD STANMORE, C.V.O., will preside.

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

APRIL 17.—F. E. LAMPLOUGH, M.A., "Vita Glass."

APRIL 24.—H. L. FLETCHER (of the British Broadcasting Corporation), "The Educational Value of Broadcasting."

MAY 1.—P. MORLEY HORDER, F.S.A., "Architectural Models."

MAY 8.—CHARLES J. FFOULKES, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts." PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, will preside.

MAY 15.—ROBERT BURRELL, Barrister-at-Law, "The Reform of the British Patent System."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

APRIL 12.—A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

MAY 10.—P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.)

DOMINIONS AND COLONIES SECTION.

Tuesday afternoons, at 4.30 o'clock.

MARCH 26.—H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa." PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., Vice-President of the Institution of Mining and Metallurgy, will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic movements in Asia." Four Lectures: April 22, 29, and May 6, 13.

LECTURE I.—The Exodus of the Arabs in the Seventh Century.

LECTURE II.—The first westward movement of the Turks in the Eighth Century.

LECTURE III.—The invasion of Middle Asia by the Seljuks in the Eleventh Century.

LECTURE IV.—The Mongol invasion of the West in the Thirteenth Century.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 18..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. M. Isacco, "The Helicogyre."

Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Special and Business Meetings.

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Method in Invention," opened by Mr. C. Turnbull.

At the University, Liverpool. 7 p.m. Mr. E. Y. Robinson, "Radio Sets on the Mains."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. O. G. S. Crawford, "Air Photographs of the Middle East."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. Keith-Brinsmead, "Locomotive Lubrication."

At the Merchant Venturers' Technical College, Bristol. 7 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture IV).

At University College, Gower Street, W.C. 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture IV).

5.30 p.m. Dr. C. J. Sisson, "English Literature among Professors and Students."

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture VI).

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. The Rev. A. H. Finn, "Conjectural Emendations in the Psalms."

TUESDAY, MARCH 19. . Automobile Engineers, Institution of, at 83, Pall Mall, S.W. 7.45 p.m. Demonstration and Discussion of Inventions.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Conrad Gribble, "Impact in Railway-Bridges, with particular reference to the Report of the Bridge Stress Committee." (Further discussion).

Electrical Association for Women, at 15, Savoy Street, W.C. 7 p.m. Mr. H. Bourne, "Some Elementary Facts concerning Electric Motors."

Electrical Engineers, Institution of, at the Engineer's Club, Manchester. 7 p.m. Messrs. T. N. Riley and T. R. Scott, "Electrical Insulating Papers for the Manufacture of Power Cables." Mr. S. G. Brown and Mr. P. A. Sporing, "The Prevention of Ionisation in Impregnated Paper Dielectrics."

At the Town Hall, Loughborough. 6.45 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture).

Empire Society, at the Cannon Street Hotel, E.C. 1 p.m. Mr. John Ryan, "The Cotton Industry."

Heating and Ventilating Engineers, at Milton Hall, Manchester. 7 p.m. Paper by Mr. A. E. Cubbage.

Illuminating Engineering Society, at 15, Savoy Street, W.C. 6.30 p.m. Mr. Walro Maitland, "Architectural Lighting."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Dr. N. F. Budgen, "Aluminium."

At Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Stanley W. Kemp, "Antarctic Whaling Expeditions."

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Dr. E. C. Snow, "The Limits of Industrial Employment."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. Philip Burtt, "What Education does a Transport Man Need?"

At the Queen's Hotel, Birmingham. 6 p.m. Mr. E. W. Bayliss, "Transport on Inland Navigations—its Advantages and Limitations."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture X).

Zoological Society, Regents' Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, MARCH 20. . Chemical Engineers, Institution of, at Grosvenor House, Park Lane, W. 11.30 a.m. Sir Alexander Gibb, Presidential Address, "The Co-ordination of Engineering Institutions and Societies."

2.15 p.m. Prof. Dr. B. P. Haigh, "Chemical Action in Relation to Fatigue in Metals."

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Mr. H. A. R. Gibb, "Foreign Policy of Egypt in the Muslim Period."

Electrical Engineers, Institution of, at Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. W. Cramp, "The Cause and Effect of Oscillation in Electrical and Mechanical Apparatus."

At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Mr. R. W. Gregory, "Electric Supply to the Rural Districts of England."

Geological Society, Burlington House, W. 5.30 p.m.

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Mr. R. A. Watson Watt, "Weather and Wireless." (G. J. Symons Memorial Lecture).

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Dr. H. Moore, "The Mode of Formation of the Image in the Microscope."

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Admiral of the Fleet the Right Hon. Lord Wester Wemyss, Presidential Address. Sir William J. Berry, "H.M. Battleships 'Nelson' and 'Rodney'." Lt.-Col. F. Dondona, "Sea Trials of Italian Destroyers."

University of London, at the London School of Economics Houghton Street, W.C. 6 p.m. Mr. J. R. Bentley, "'Hollerith,' To-day and To-morrow."

THURSDAY, MARCH 21. . Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Automobile Engineers, Institution of, at the Technical School, Gloucester. 7.30 p.m. Mr. L. W. Johnson, "The Inspection of Metals and their Alloys."

Electrical Engineers, Institution of, Savoy Place, W.C. 5.30 p.m. Demonstration by Mr. R. T. Coe of a Portable Electric Harmonic Analyser. 6 p.m. The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages." Mr. J. A. Kuyser, "Recent Developments in Turbo-Generators."

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. John Hooper, "The Furnishing of Official and Diplomatic Residences."

Mechanical Engineers, Institution of, at Queen's Hotel, Birmingham. 6.30 p.m. Messrs. A. J. Assheton and A. G. Engholm, "Sub-Atmospheric Heating."

At the Engineers' Club, Manchester. 6.30 p.m. Mr. F. C. Johansen, "Research in Mechanical Engineering by Small-Scale Apparatus."

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Mr. John Johnson, "The Propulsion of Ships by Modern Steam Machinery." Dr. J. Bruhn, "Some Considerations Regarding International Loadline Regulations."

3 p.m. Dr. G. Kempf, "New Results Obtained in Measuring Frictional Resistance." Mr. C. F. A. Fyfe, "The Practical Use of the First British-Built Bauer-Wach Exhaust Steam Turbine Installation in the Booth Liner 'Boniface'."

8 p.m. Professor C. E. Inglis, "Natural Frequencies and Modes of Vibration in Beams of Non-Uniform Mass and Section." Mr. S. A. Hodges, "The Behaviour of Stiffened Thin Plating under Water Pressure."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Change in Meaning from one Period to Another."

Sanitary Institute, 90, Buckingham Palace Road, S.W. 3 p.m. Sir Humphry Rolleston, "Industrial Disease and its Prevention."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture VI).

FRIDAY, MARCH 22. . Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. D. A. Collin, "Ventilation."

Medical Research, International Association for, at the Royal Society of Arts, Adelphi, W.C. 7 p.m. Lecture by Dr. F. W. Zeylmans van Emmichoven.

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Eng. Rear-Admiral W. Scott-Hill, "Powdered Coal for Ships." Mr. A. Spyer, "Modern Developments of the Water Tube Boiler for Marine Purposes." Eng. Rear-Admiral A. E. Hyne, "Suggested Modifications to Marine Water Tube Boilers."

3 p.m. Mr. J. Rennie Barnett, "Motor Life-Boats of the Royal National Life-Boat Institution."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Annual General Meeting. Dr. W. H. Eccles, F.R.S., Presidential Address.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Ernest Rutherford, "Penetrating Radiations."

University of London, at University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture X).

SATURDAY, MARCH 23. . L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. M. A. Phillips, "Mammals of Britain."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3983. VOL. LXXVII.

FRIDAY, MARCH 22nd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

TUESDAY, MARCH 26th, at 4.30 p.m. (Dominions and Colonies Section). H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa." PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., will preside.

Tea will be served in the Library from 4 o'clock.

PURCHASE OF WEST WYCOMBE.

It has been felt for some time that the Royal Society of Arts should extend its work for the Preservation of Ancient Cottages by acquiring complete villages in order to show the public what can be done by intelligent control of its traditional values. The idea originated during the chairmanship of Sir Frank Baines, and was encouraged by Sir Lawrence Weaver, who, after a visit to America, reported that he could find very little support for a general and vague scheme for saving scattered cottages, but that he hoped help would be forthcoming if certain definite villages could be taken in hand. Sir Howard Frank was then asked to report on any suitable villages that might come into the market. He suggested one or two in Wiltshire, and also West Wycombe in Buckinghamshire, which was to be put up for auction in a very few weeks. A lady in the district at once offered to contribute £500, and assured the Committee that others in the neighbourhood would be glad to assist, in order to prevent the village being handed over to a number of irresponsible owners, who would quickly change the whole character of the place.

Sir John Dashwood, of West Wycombe Park, owner of the village, was approached. Appreciating the advantages of selling to a responsible society

who would have complete control of the buildings and whose object would be solely to restore and retain their true character, he did everything in his power to further the scheme both in settling the price and promising a subscription of £500 to the repair fund. Various members of the Executive Committee visited West Wycombe; an emergency meeting was called to consider Sir John Dashwood's offer, and they unanimously recommended the Council to accept it. The Council at their meeting on March 11th agreed to make the purchase and authorised the payment of the deposit.

The village of West Wycombe is particularly interesting by reason of its close proximity to the unpleasing suburban outcrop of High Wycombe on the one side and the fine open country on the other. It is bounded on one side by West Wycombe Park and on the other by common land, so that if the village is once placed in good order there is little danger that it will ever be spoiled. Lying on the high road between Oxford and London, it will be seen by large numbers of people, and it is hoped that the work of preservation begun here may lead to similar developments in other counties.

A strong local committee is being formed in Buckinghamshire with a view to raising the money necessary to pay for the purchase of the village and to carry out the necessary repairs. An appeal has been issued and already a substantial sum has been received or promised. The Society is most anxious not to deplete its resources for dealing with other pressing problems and therefore hopes to get a sum of at least £20,000 for this particular purpose. All those who are interested in saving this very picturesque village are requested to send their subscriptions to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2, by whom they will be gratefully acknowledged.

HISTORY OF THE ROYAL SOCIETY OF ARTS.

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15s. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

COUNCIL.

A meeting of the Council was held on Monday, March 11th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Lord Bledisloe, P.C., K.B.E.; Captain Sir Arthur Clarke, K.B.E.; Sir William Henry Davison, K.B.E., D.L., M.P.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Mr. P. Morley Horder, F.S.A.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E.,

D.S.O.; Sir Philip Magnus, Bt.; Sir Richard Redmayne, K.C.B.; Col. The Master of Sempill; Mr. James Swinburne, F.R.S.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas; Sir Frank Warner, K.B.E., and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society:—

Adams, Alfred Courthope, London.
Baird, John Logie, London.
Barnes, James Haydn, M.A., Bath.
Candish, Herbert Douglas, Edgware.
Davidson, Thomas William, Totteridge, Herts.
Edwards, James Herbert, M.I.E.E., Cranham, Glos.
Hall, Captain Joseph Lockwood, F.R.I.B.A., Pretoria.
Howells, Frederick Walter, Bristol.
Hubbard, E. Hesketh, R.O.I., A.R.W.A., R.B.A., Salisbury.
Impey, Frederic Paul, London.
Lofts, Harold George, West Harrow.
Singh, Dr. Jaswant, L.M.P., Kashmir.
Taylor, Gilbert, London.
Turner, Captain J. Dare Knobbs, A.M.I.Mech.E., London.

A statement by Mr. P. Morley Horder, Chairman of the Committee of the Fund for the Preservation of Ancient Cottages, recommending the purchase of the village of West Wycombe, was considered, and the recommendation of the Committee was approved. [See page 475].

A report from the Thomas Gray Memorial Trust Committee was approved, and prizes to the value of £100 were awarded. [See below].

The number of entries for the March Examinations was reported—26,882.

A quantity of financial and formal business was transacted.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1929 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce."

A list of those who have received the medal since its institution in 1864 was printed in the last number of the *Journal.*

THOMAS GRAY MEMORIAL TRUST.

Award of Prizes.

Prize for an Invention for the Improvement of Navigation.—Under the Thomas Gray Memorial Trust the Council offered a Prize of £100

for a valuable improvement in the Science or Practice of Navigation. The last date for receiving entries for this Prize was December 31st, 1928. Ten entries were received. These were carefully considered by the judges appointed by the Council, who report that in their opinion none of the inventions submitted was of sufficient value to justify the full award of the Prize. There was certain merit or interest, however, in two of them, and in accordance with the judges' recommendation the Council has awarded prizes as follows :—

A Prize of £30 to Lieut. Donald MacMillan, R.N.R., for his "Navigators' Ex-Meridian Diagram," and

A Prize of £20 to Captain John Barrance Browning for his "Browning Star Plotter."

PRIZE FOR AN ESSAY.—The Council also offered a Prize of £50 for an essay on "The Practice of Navigation in the Mercantile Marine." Eighteen essays were submitted and in accordance with the unanimous recommendation of the judges, the Council has awarded the Prize to Mr. P. S. Atkins, Second Officer, T.S.S. "Sarpedon," Blue Funnel Line.

FIFTEENTH ORDINARY MEETING

WEDNESDAY, MARCH 13th, 1929. DR. WILLIAM HENRY ECCLES, D.Sc., F.R.S., in the Chair.

A Paper on "Loud Speakers," was read by MR. R. P. G. DENMAN, A.M.I.E.E., of the Science Museum, South Kensington. The Paper and discussion will be published in the *Journal* dated May 17th.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

WEDNESDAY, JANUARY 30TH, 1929.

JAMES SWINBURNE, ESQ., F.R.S., in the Chair.

The following paper was read :—

THE SHANNON SCHEME AND ITS ECONOMIC CONSEQUENCES.

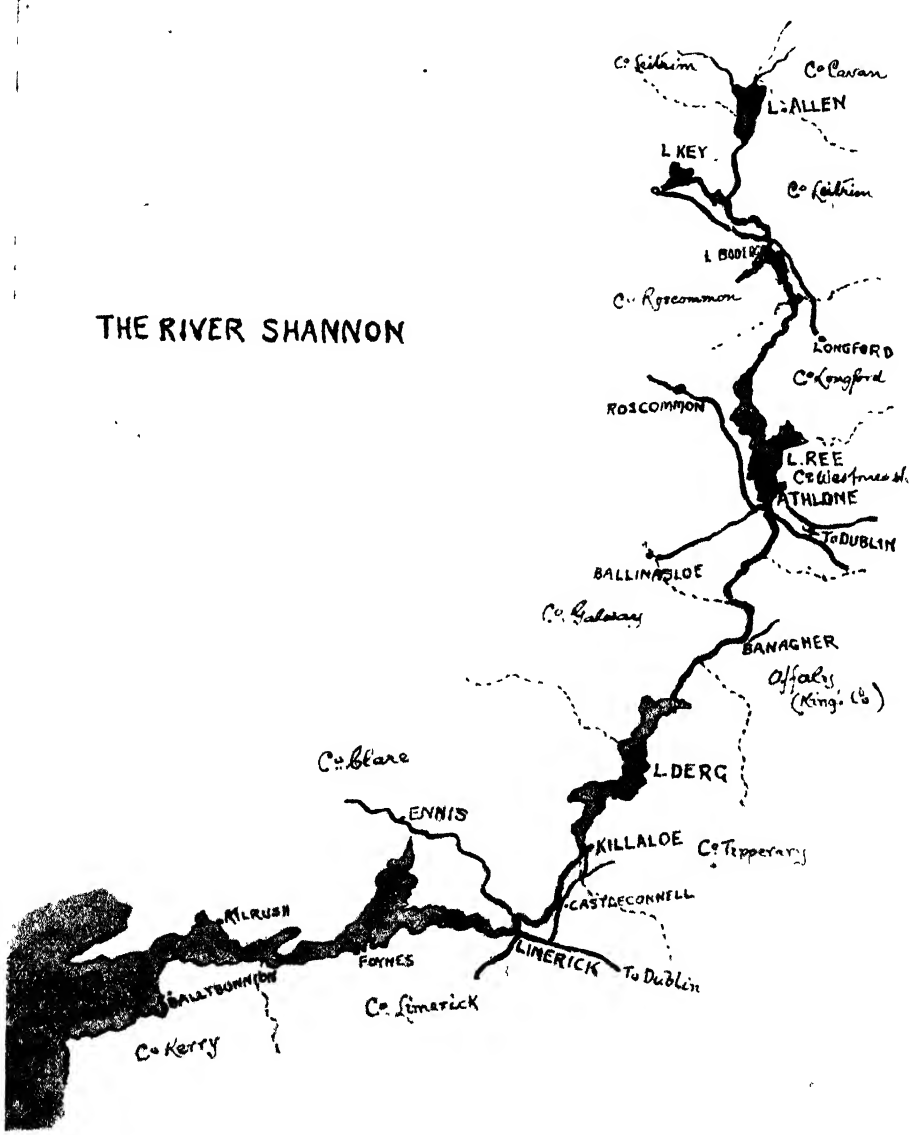
By GEORGE FLETCHER, M.A., F.G.S., M.R.I.A.

In a paper on "The Power Resources of Ireland," which I had the honour to read before this Society in 1922, under the Chairmanship of the late Sir George Beilby, I gave some particulars of the water power resources of Ireland

and of the findings of the Water Power Resources of Ireland Sub-Committee of the Board of Trade. This Committee, of which I was a member, had as its Chairman a very distinguished Engineer—Sir John Griffith. It recommended, *inter alia*, a development of the water power of the Shannon. The Scheme suggested was different in character and on a much smaller scale than that which was untimately adopted by the Free State Government, and which I am about to describe. The Committee, which reported on December 6th, 1920, submitted detailed schemes for the development of the Lower Bann, the Lower Shannon, the Lower Erne and the Liffey, and expressed the opinion "that in most cases the most effective and economical method of dealing with our rivers for power purposes is to construct the necessary works in the channel of the river, and not to attempt to seek high falls by the construction of costly head-race channels, into which a portion of the river flow would be diverted from the channel proper." The Report set out the advantages of adopting such a course, and the scheme submitted by Mr. Stephens proposed to erect four hydro-electric power stations on the Shannon between Killaloe and Limerick, with an installed electrical horse-power of 65,900, at a total cost (under the then current prices) of £2,834,000, or at the rate of £43 per installed E.H.P. The average annual output obtainable would be 52,000 E.H.P., at a capital cost of £54 per average E.H.P. It is unnecessary at this time to explain fully the reasons which induced the Committee to recommend this scheme of progressive development, but chief among them was that of dispensing with a costly head-race, the conservation of fishery interests, the improved navigation facilities and the progressive development in relation to demand for current.

This is neither the time nor the place to discuss the reasons for the promulgation of a scheme which differed so widely from that recommended by the Committee. The question is discussed at some length in the Report of the Experts, to which reference is made later. The Committee were agreed that such large rivers as the Shannon should be in the control of a Department of State. Previous attempts to develop the river had been baulked by rival, though subsidiary, interests, and it became clear that these needed the authority of the State to bring about such reconcilement as was possible under any large scheme for the production of power from the river. An instance of this conflict of rival interests is that afforded by the earlier proposal of Mr. Frazer. An Act of Parliament was passed in 1901 (1, Ed. VII, c. 136), under which it was proposed to divert a portion of the river water below Killaloe to a power station, but the restrictions inserted in the Act, at the instance of the Board of Public Works and the Department of Agriculture and Technical Instruction in the interests of navigation and fisheries, proved fatal to the proposal, which was not proceeded with. Further proposals were made by Mr. Stephens, who, after extensive surveys in 1915, on behalf of the Irish Hydro-Electric Syndicate, proposed to follow the lines of the Act of 1901, adopting its restrictions, and

obtain 40,000 h.p. for from 17 to 20 weeks in the year and 17,000 h.p. throughout the year. The intention was to obtain power for the manufacture of ferro-chrome. The Water Power Resources of Ireland Sub-Committee was appointed on November 29th, 1918, and reported on December 6th, 1920. The problem was further considered by a Commission of Inquiry into the Resources and Industries of Ireland, which reported in 1922. An agreement, published as a White Paper, was made between Messrs. Siemens-Schuckertwerke and the



Irish Free State Government in February, 1924. Their proposals were submitted to the experts appointed by the Government, and these, in the early part of 1925, recommended, with some modifications, the adoption of the scheme. The scheme now in progress was passed by Dail Eireann on April 3rd, 1925, and the Shannon Electricity Act passed the Oireachtas in June of the same year.

Before describing the scheme it will be useful to give some particulars about the river. The Shannon is the longest of our Irish rivers. The total length of its main stream, exclusive of the tidal estuary below Limerick, is about 160 miles, and its catchment basin, above Killaloe, has an area about one-eighth of the total area of Ireland—over 4,000 square miles. Above Killaloe, the river, meandering over the central plain and passing through its three large lakes, Lough Allen, Lough Ree and Lough Derg, has, in 125 miles of its length, a fall of only 55 feet—less than 6 inches per mile. Flooding of the areas adjacent to the river has been a constant source of trouble, and has been considered by a number of important Commissions. The question still offers a problem of pressing importance. In September, 1924, the Free State Government submitted the scheme offered by the Siemens-Schuckert Company to four experts for examination and report. These were Messrs. Waldemar Borgquist of Stockholm, Eugen Meyer-Peter of Zurich, Thomas Norberg Schulz of Christiania and Arthur E. Rohn of Zurich. These gentlemen, in their Report, drew attention to the importance of the drainage problem, and recommended the Government to have a drainage scheme prepared for Shannon areas subject to flooding, in connection with the lake and river regulation necessary under the Power Scheme. They, at the same time, expressed the opinion that, in spite of the often-expressed fears to the contrary, the hydro-electric exploitation of the Shannon, especially in the full development, will regulate conditions as regards maximum height of water and flood prevention, providing in addition the protective constructions which at present are lacking, and also that the developed electrical energy may be used to a far-reaching extent to drain areas in the country subject to flooding.

Below Killaloe, and from there to Limerick, a distance of 15 miles, the fall over the river is over 90 feet, or 6 feet per mile, and this fall is being utilised for the production of power. It is obvious that the first point of importance in such a matter is the flow-off conditions—involving both quantity and time. In this matter the conditions in Ireland are very favourable as compared with most Continental countries, for the greatest flow occurs in winter, when the demand for energy is greatest.

It was of great advantage that there was in existence an extensive record of observations (made by the Board of Works), both as regards rainfall in the area and of Water level at various points. These have been discussed in the Report of the Experts appointed by the Government: "The Electrification of the Irish Free State" (Dublin, The Stationery Office). I do not propose to

Shannon Power Scheme.—Sketch diagram.

enter into the difficult and complicated question of flow-off, but with a rainfall of 946 m.m., the average discharge of water in the lower part of the river is 240 c.b.m. per second. The maximum discharge in flood is 918 c.b.m. per second and the minimum dry-weather flow is 25.4 c.b.m. per second—thus the ratio of the largest quantity of water in flood to the lowest quantity in dry weather is 36:1. It will be clear that to utilise the energy to the full it will become necessary to impound the water during the period of heavy flow in order to supplement the flow in the dry weather period, and it is this which renders the question of storage in the lakes one of great importance. By raising the level of the lake reservoirs the amount of water stored may be increased at a cost of flooding the neighbouring lowlands. By lowering the level of the lakes a large amount of the stored water may be used when needed, but this course is attended by difficulties which arise from altering the navigation level and the like. In the present case—the "partial development" of the Shannon—the existing maximum and minimum levels of the three lakes will not be interfered with, except in the case of Lough Derg, the level of which, while it will be maintained at its present winter level as far as may be, may be lowered two feet in a dry year, by which a storage of 186 million cb.m. will be secured.

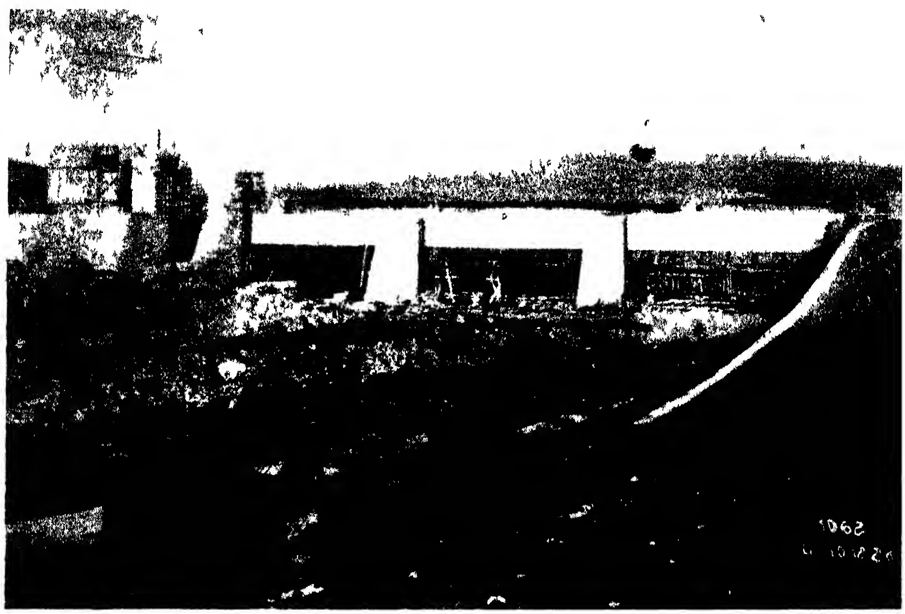
The Scheme contemplates development in three stages: (1) the Partial Development, involving the lowering of Lough Derg by two feet, the protection of the land on its shores, where necessary, by embankments, the land behind which will be drained by pumps, bringing the water back into the lake; (2) the Further Development, involving a new weir at Lough Ree and the rebuilding of the Lough Allen Weir; (3) the Final Development, in which the storage of the three lakes will be increased by a further raising of the maximum water level of Lough Derg by nearly 7 ft. (2.10 m.).

The Partial Development (which necessarily includes certain provision for subsequent developments) consists of a diversion of a part of the Shannon river along a head-race, which conveys the water at a constant level until it reaches the Power Station weir, where it is carried through steel penstocks to the water turbines, which are connected by vertical shafts to electric generators placed above them, and is then discharged into the tail-race, which joins the river nearly 1½ miles below. Thus a fall of some one hundred feet is utilised. The water level in the tail-race is influenced by the tide, but the net fall varies from 86 feet to 115 feet. At normal water level and average tide it is 94 feet.

The important structural elements of the Scheme are then seen to be: (*a*) the intake works and embankment and control works up stream; (*b*) the head-race with the bridges over it and the siphons under it; (*c*) the penstocks and power house, with its turbines and electric generators; and (*d*) the tail-race.

THE INTAKE WORKS.

It will be seen from the plan that these provide for a weir controlling the amount of water admitted to the river, which is regulated by the sluices, so as to provide the quantity required in the head-race, while the admission of water to the latter is controlled by sluice gates in the three openings of the intake building, each 25 m. wide and 5.7 m. deep and worked—either electrically or mechanically—from the roofed gangway above. This also provides a ships' pass 10 m. wide and 5.9 m. deep. Underneath this building is a reinforced concrete siphon to take the water of the Black river, etc., into the Shannon below the weir. This siphon is nearly 400 feet in length. The weir will raise the river level about 23½ feet above the present average level involving embankments between the weir and Lough Derg. The intake works and



Weir Intake Works looking upstream. Steel Gates under erection.

weir are near Parteen Villa and are built on an old red sandstone foundation.

The very important question of the erosive effect below the weir was made the subject of experimental investigation, and for an account of the model experiments carried out at the Technical High School, Berlin, I am indebted to a paper recently read by Professor Rishworth, Government Engineer for the Scheme, before the Institution of Civil Engineers of Ireland. The weir design provided for four openings, each 18 m. wide, with weir crests at a level of 33.00 m. (full development), and two deep sluices, 10 m. wide, with weir crests at a level of 24.80 m. (partial and full development). The river bed downstream was taken at an average level of 24.50 m., and the upper surface

of the rock at 22.00 m. The river bed at the weir consists of old red sandstone covered with shingle and silt. The river, however, is too near Lough Derg for there to be any silting up of the river bed above the weir. The maximum flood was taken as 920 cb.m. per second, and it was assumed that it may all have to be discharged through the weir in case the Power Station is closed down altogether and no water is flowing through the head-race.

The preliminary experiments clearly indicated that considerable erosion downstream might be expected from the deep sluices, and it was decided to keep them in the centre of the river so as to minimise the erosion of the banks.

The model was made to a scale of 1 to 50. Doctor Ing. Ludin, under whose supervision the experiments were carried out, made numerous experiments to determine the nature of the sand most suitable to be used to represent the existing hydraulic phenomena.

An exhaustive series of experiments were carried out, for an account of which I must refer you to the paper quoted. They led to a modification in the design of the weir. The question arose as to whether a stop wall was necessary at the end of the extended spill basin, and if so, of what section. Experiment showed that the most suitable form was Professor Rehbock's toothed or dentated stop wall, but an almost equally satisfactory result was found with a wall of almost rectangular section with a uniform sill slightly sloping downstream with a height of 1 m. above the floor of the spill basin. The latter was adopted owing to its constructional advantage.

It was decided to adopt Model C as the basis of the weir design with certain modifications indicated by further experiments—thus the most suitable height for the stop wall was found to be 2 m. above the floor of the spill basin and maintained throughout the whole width of the weir.

HEAD CANAL.

The construction of the head-race or inlet canal, by which the water is diverted from the existing river course and conveyed at a constant level a distance of over 7½ miles to the Power House, presents a series of difficult and interesting problems. The question of speed of flow with partial and full development in relation to navigation, which will be through the head canal, the problem of preventing leakage and of possible injury which might result to the slopes of the canal by the waves set up by barges or of the swell resulting from a sudden shutting down of the turbines, the interference with the existing land drainage, are all problems which had to be met and overcome.

The experts were of opinion that a maximum speed of 1.5 metres per second might certainly be permitted. The greatest depth of water in the canal is 37 feet with a maximum width of 297 feet at the water surface. The bed is 104 feet wide and the side slopes are 1:3.

The canal passes through a rock cutting in two places—one of old red sandstone (between the intake and O'Brien's Bridge, and one of silicious

limestone at Clonlara. Provision is made for protection of the deep lying slopes and bed of the canal where these do not lie in rock by a layer of broken stones, and the upper part of the slopes subject to wave action are protected with concrete slabs.

The drainage of the area lying above the head canal is dealt with by culverts passing under it, the largest of these being the siphon under the weir which carries the Blackwater. There are also three bridges over the head canal.

PENSTOCKS AND POWER HOUSE.

The Power House is situated at Ardnacrusha, a few miles above Limerick. The building here, as elsewhere, is of reinforced concrete. The illustrations indicate the progress of the work and show the six openings to carry the

Shannon Power Station under construction as seen from Navigation Canal. (Photo by courtesy of Messrs. Siemens' Bau Union).

intake pipes and the navigation lock. Three of these only will be utilised for the Partial Development. They carry three steel pipe lines. These are 20 ft. in diameter and 145 feet in length and carry the water from the head canal (after passing through a screen, or "trash rack," to remove any stones or branches) to the turbines. The water then passes through a conical inlet pipe (tapering from 20 ft. to 15½ feet in diameter) to the spiral housing (embedded in concrete), and thence through the guide-vanes to the turbine runner. It is then discharged through the draft tube to the tail-race.

The three turbines to be installed will each have an output of 38,600 h.p. These Francis turbines have vertical shafts connected directly to 30,000 k.w. 10,500 volt 50-cycle generators. The turbine speed will be 150 revolutions

per minute. The building of the generating station will provide for the installation of three further units of the same size in the future.

A thrust-bearing, mounted above the generator, will take the downward thrust caused by the weight of the revolving parts. These weigh about 20 tons and are designed to withstand a downward pressure of 480 tons. There are many interesting and important points connected with the speed control of the turbines and with lubrication, which is effected by means of a motor driven pump—that of the thrust-bearing by a pump mechanically driven off the turbine shaft.

THE TAIL-RACE.

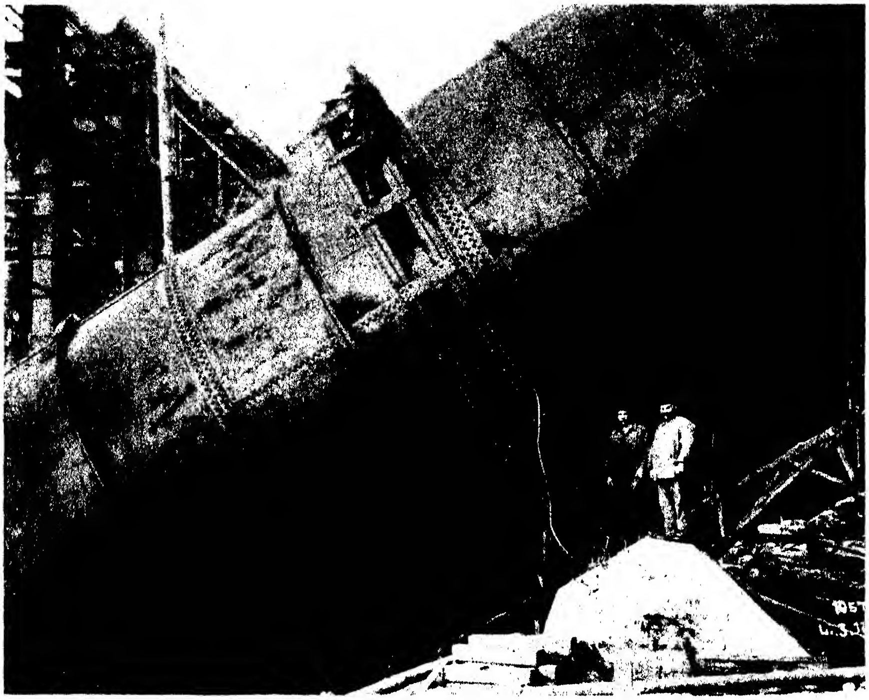
This is over 2,000 yards long and runs through rock. For the Partial Development it will have a width of 70 feet, but this width will be doubled for the Full Development. The current in this will not exceed 1.5 metres per second.

DISTRIBUTION.

I have already stated that current will be generated at 10,500 volts. It will be stepped-up to voltages of 110,000 volts and 38,000 volts and distributed over nearly the whole of the Irish Free State by overhead high-tension transmission lines, as shown in the diagram, which shows the lay-out for the First or Partial Development. The 110 k.v. lines, which form the primary distribution system, will run from Ardnacrusha to Dublin (6 conductor) and from Ardnacrusha to Cork (3 conductor). These distances are 116 miles and 59 miles respectively. At each of these points are 110/38 k.v. transformers. The 38 k.v. transmission system is designed for the loop distribution, which, when completed, will extend about 1,040 miles. At the points shown in the map are transformers for converting the current from 38,000 volts to 10,000 volts, and these stations supply a further distribution system. This system is for local distribution and will supply numerous transformer stations in cities, towns and villages, where the current will be transformed to voltages of 380 and 220 volts, which are the low tension voltages adopted for industrial and domestic consumers. The 110 k.v. lines are supported on lattice steel masts. The 38 k.v. lines are supported on lattice steel masts in the southern area and on wooden poles in the northern area, while wooden poles are used exclusively for the 10 k.v. lines.

The erection of the high transmission lines was the first work undertaken and is now in a very advanced stage. Rapid progress has been made with the Central Station work and it appears very probable that the supply will be available by October of this year.

It is only possible in the time at my disposal to give this general sketch of this great engineering undertaking—a work in which over 5,000 men have been employed and an elaborate equipment of modern engineering plant. It is



Penstocks under erection.

Elevation of Power House and Power Intake Works under Construction.
(Navigation Lock on Extreme Right).

hoped that advantage may be taken of the present stage of the work to visit and inspect this interesting project.

ECONOMIC CONSIDERATIONS.

I must, however, turn to a wider question, that of the economic developments which may be expected when electric power is available throughout the Free State. One is frequently met by the question—uttered in a tone of obvious misgiving—whether this great Scheme will " pay " ; and this is not uncommonly accompanied by an expression of doubt in the matter, because Ireland is " not an industrial country." The question is characteristic of our national attitude to such matters. The question is reasonable enough, but our national caution often leads us to defer action until a mathematic demonstration can be given, and this comes too late—the opportunity has passed. The exploitation of our water-power resources has been too long delayed, especially in Ireland, which has suffered from its lack of fuel. Yet even now he would be a bold man who should essay a mathematical demonstration of the economic success of the Shannon Scheme, though, in my own view, this success is assured. Permit me briefly to sketch the position as it is to-day. The chart on the screen shows the population of Ireland, the area of land under tillage and the number of cattle in Ireland in successive decennial periods since 1841. It will be seen that the population has rapidly declined and that in 50 years it fell almost by one-half —from over 8 millions to slightly over 4 millions. It is still falling. It will be seen also that the area of land under corn crops decreased at about the same rate, and though there was a temporary recovery during the War the downward tendency continued. It appears that this causal relationship between decrease in tillage and population almost ceased to operate after 1881 (see Agricultural Statistics for Saorstat Eireann, 1847-1926). We need not consider too closely the causes of this. The supply of cheap corn from America and elsewhere affected farmers in Britain as well as in Ireland, where the cattle industry increased by leaps and bounds, but for the carrying on of which far less labour was required. Hence emigration took place at an alarming rate. But there was this difference in the effects produced in the two countries. In England the population migrated to the rapidly-growing industrial towns where power-factories near the coalfields absorbed the erstwhile agricultural labourer. In Ireland there were few industrial towns, there being very little coal, and so the population fell by emigration. In the last few years there has been great improvement in the organisation and marketing of products in the great dairy industry and other branches of agriculture in the Irish Free State, but it is becoming clear that a vigorous industrial revival is essential unless emigration is to continue. Efforts to promote industries other than agriculture in Southern Ireland during the last thirty years have been fitful and half-hearted. Official effort took the direction of encouraging home industries, and these achieved a large measure of success, were of considerable educational

value and proved a useful auxiliary to the earnings of the small farmer. This afforded no solution of the larger problem, however. The farming classes are not industrially-minded and the prospect of the mill chimney revolted them. The few industrial ventures which were attempted usually ended in failure. Concurrently a number of home industries followed the normal course of decay. The spinning wheel became a museum specimen or drawing-room ornament, thousands of hand-looms went on to the scrap-heap, the lace and crochet industries wilted before the vagaries of fashion, the once extensive "sprigging" industry of the north-west was largely lost to the machines of Switzerland and Germany, from which we sought with some degree of success to recover it. But it is a fact that machine industries have not come to take the place of the hand industries, although there are certain important industries in which the cost of power is a small, though not negligible, factor. Many once flourishing towns are falling into decay and have ceased to provide for the needs of the rural areas surrounding them, and articles which they once manufactured for themselves are now imported. This unhappy state of things is due largely, but not entirely, to the lack of fuel resources, and to-day industry calls for cheap power. The Free State has coal resources, but it does not compete with English coal and does not raise more than about one-fortieth of the quantity it imports. It has valuable peat resources—the salvation of the rural population, who use some six millions of tons every year for domestic purposes—and these reserves, which are abundant, will undoubtedly prove a great industrial asset in the future. Machine peat of good quality and having a heat value of about 7,200 B.T.U.'s per pound* (25 per cent. moisture) can be won and stacked on the bog at Turraun for 10s. per ton. Certain problems of transport remain to be solved, but it seems likely that electric transmission may, in time, afford a revolution.

It will be seen from the foregoing that the primary economic need of the Irish Free State is cheap electric energy for lighting and power purposes, and this it will be the function of the Shannon Scheme to provide. The first effect will be to improve greatly the amenities of our country towns and to raise the standard of comfort of those living in them. There are approximately 130 towns and villages, with a minimum population of 500, in which no electric supply at present exists. As many of these as possible will be given the benefit of the current when it becomes available. Contracts have been given for the erection of distribution networks in more than thirty of them. Many of these towns are situated among beautiful natural surroundings, and the advantage of an electrical supply for street and house lighting will be of enormous value, social and economic, and will react on the growing tourist traffic, the importance of which has been recognised and has led to the formation of an Irish Tourist Association. A very important consideration also is that in such places the working day will be greatly lengthened.

*"Peat as a Domestic Fuel" by G Fletcher, Irish Trade Journal, April, 1927 (Vol. II., No 7.)

It is not possible at this stage to estimate to what extent the supply will be made use of by the agricultural industry, but with adequate propaganda it is certain to play a very important part in the staple national industry. Nor can one yet forecast the effect of the supply in attracting new industries, which require cheap power, but, arguing from analogy, the availability of cheap power, with other economic advantages, will almost certainly attract them. The surplus energy available in winter may also, in seasonal industries, afford winter employment to a certain number of otherwise idle workers, and we may hope that, as the experts expressed it, "the various proposals for the development of hydro-electric power at present put forward will in time come to be realised."

DISCUSSION.

THE CHAIRMAN said the audience had had a most excellent account of what was, he imagined, by far the greatest industrial undertaking ever ventured upon in Ireland. Everyone hoped it would be as successful as it looked likely to be.

PROFESSOR T. WIBBERLEY said the lecturer had given a most admirable paper, but had failed to deal with the application of electrical energy to what was, and what he (the speaker) always hoped would be, the greatest industry in Ireland, namely, agriculture. A lot of trash had been talked about the application of electrical energy to agriculture. It had been stated that electrical energy was very good for pulping turnips. The average farmer grew just about enough turnips to keep himself nicely warmed in the morning doing that by hand. Then it had been stated that electrical energy was a good thing for chaffing hay. Again, the average farmer only fed sufficient livestock to justify him occupying about one hour of his time cutting hay with which to feed his cattle in the winter-time. If one was going to think on those small lines in connection with a big scheme like the Shannon Scheme one was not going to get very far. It was not only necessary to electrify the country; it was necessary to electrify the mentality of the Irish people—to give them a new outlook on life, to make them forget the past, and to live for a present and a future. He had only just returned from a fortnight's tramp through the peasant villages of Ireland, and he felt quite sure that the immediate development of the Shannon Scheme must be very closely linked with the country's agricultural development. Although we were living, both in this country and in Ireland, in a time of great agricultural depression, as a large farmer as well as a supposed scientist, he was convinced that the solution of the agricultural question in this country as well as in Ireland would be found in synthetic nitrogen—one of the greatest achievements of the present century. He would like to indicate how electrical energy could materially and directly benefit the farmers. It had been found, as the result of direct experiment, both in America and this country, that, by having an arrangement made whereby in the winter months a light was turned on in a fowls' house about one o'clock in the morning, the poor unfortunate hen was deluded into the belief that another day was dawning, the hens got down and had a feed and the result was that the output of eggs could be increased by no less than 25 per cent. People might not think much of that, but he remembered that at the time of the ill-fated Convention he had shocked a lot of people from Belfast, who had stressed a great deal the importance of the shipping and linen industries of Belfast, by pointing out that the net revenue of Ireland from the eggs and the feathers of fowls was

far greater than the net revenue from the shipping industry when it was in its heyday. Egg production was a very important industry in Ireland, and was likely to continue to be so. Synthetic nitrogen was about the one and only example there was of a modern scientific sword being turned into a ploughshare. The manufacture of synthetic nitrogen had occupied the minds of scientists for at least a hundred years, but not until nitrogen had been wanted for high explosives for destructive purposes had the necessary capital been forthcoming to help to make it. It had been made, however, and through the genius of Lord Melchett in this country at least, synthetic nitrogen had now been turned to agricultural uses. An organisation known as Nitram Ltd. had demonstrated one of the most important discoveries of the present century, namely, that by applying nitrogen heavily on pasture land not only could the period of grazing be increased by four weeks at either end of the ordinary grazing season, but the nature of the grass could be completely altered. In a country where 90 per cent. of the land was under grass, as in Ireland, that was bound to be of most outstanding benefit. The little work which he himself had done had been to try to start a system of arable stock farming with a view to providing cheap winter food, meat and milk; and the system of cropping to which he had referred was one which would do away with the importation of feeding stuffs for cattle and sheep through the winter. It had not been possible to apply it except on a small scale in the past, because one of the essential features in connection with that intensive system of arable stock farming was the supply of cheap nitrogen, and cheap efficient Farm Tractors; both were now obtainable. One of the big developments with regard to the Shannon Scheme was the conversion of the electrical power available for the manufacture of synthetic nitrogen.

There was another possible development. Despite what geologists said to the contrary, there had been discovered, and was now being worked, a huge deposit of rock phosphate in County Clare quite close to the Shannon Scheme, and a modern development with chemical manures was to make them contain not one but two elements of nutrition such as ammonium phosphate. With that huge deposit of rock phosphate so close, and the fact that it could be water-borne to any part of Ireland, and the existence of cheap electrical power such as was necessary for the manufacture of nitrate of lime and calcium cyanide, it seemed to him that the manufacture of synthetic nitrogen would mean the setting up of a very big industry, providing employment for a large number of industrial workers, and an immense benefit to the agriculture of the country. He was afraid the men who were going to carry out the necessary propaganda among the farmers of Ireland had a very difficult task before them. He was afraid they would never succeed with the older type of men, but there did exist the younger type of men. They were the hope of Ireland; they had taken up education, and it was those young men on which the future of the country must be built.

Mr. Llewelyn B. Atkinson (Past-President, Institution of Electrical Engineers) said the Society might congratulate itself on having this very important power scheme brought before it by one who was so competent to deal with it, and who was so conversant with its history. It had so happened that on Saturday he had had an opportunity of going all over the scheme when, through the kindness of the Chief of the Irish Electricity Board, every convenience had been placed at the disposal of himself and the President of the Institution of Electrical Engineers, who had accompanied him. While he felt that the audience had had a very admirable lecture, he was to a certain extent rather disappointed that they had not heard quite as much about the economics of the scheme as the title had led them to hope.

After he had been all over the scheme the question which had been left upon his mind, knowing something of the present possible consumption of Ireland, had been, " Is this all a dream ? " The whole thing was on so vast a scale. The slides shown that evening hardly conveyed the great size of the head race which was going to carry nearly the whole of the River Shannon along to the top of the turbines. The illustrations of the excavating machines did not give any idea of the immensity of those machines. He had never seen anywhere in Europe excavating being done on so wonderful a system. The question was, what was going to be done with all that enormous power—because there would be 180,000 h.p. eventually ? What was going to be done with it was the great question. Professor Wibberley had spoken of its part utilisation for the production of synthetic nitrogen—although a good deal which had been said that night of the nitrogen processes had nothing whatever to do with water power, but were catalytic processes of uniting nitrogen with other materials. Putting that on one side, however, he could not help having the sort of feeling that this great undertaking was a national gesture of a change which was going to come over Ireland. The fact remained that to-day Irishmen were controlling their own destiny, and he believed that the Shannon Scheme was more than a mere engineering scheme. It was an economic and psychological gesture that Ireland was going to change her methods and come into line with modern views of life and modern methods of life, both agricultural and industrial. If industry was to be attracted to Ireland it would only be so if industrialists found there an industrious and energetic population. He agreed with Professor Wibberley in that connection with what he had said about the younger generation. He believed that the Shannon Scheme would reflect itself into the minds of that younger generation and would strengthen that will to work, which was the one thing which had been lacking for the last half century, in the southern part of Ireland at least. If that was the case, then he had no doubt, with this great source of cheap power at hand, that there would be no difficulty in industries going into Ireland. All kinds of industries which required great amounts of power could be planted there if the people there had the will to work at industry as well as farming. That was the view which during the last three days had been gradually percolating into his mind. The cost of the scheme was roughly £5,000,000. Of that sum, £2,500,000 was being put into the civil engineering works, of taking hold of the River Shannon, of carrying it along that seven miles of head race along the upper levels, and of putting it down again into the lower levels. Another £2,000,000 would go into the overhead lines which were to take the power all over Ireland ; and the actual machinery constructions, turbines and electrical equipment at the generating station and so on, and the transformers, would cost about £500,000. Therefore it was nearly all a matter of plant and of very little maintenance.

He strongly urged everyone who could to go over to Ireland and to inspect for themselves what was really a very wonderful work.

The Rt. Hon. Sir Thomas Molony, K.C., said he thought there was a great deal in what the previous speaker had said, namely, that this great Shannon Scheme could not be looked upon entirely as a mere work of engineering, but was to be regarded as having a deeper psychological basis—as a new starting ground for the Irish people. Irishmen all looked forward to the fructification of this great industrial development in Ireland, which he hoped, as time went on, would bind England and Ireland together by still closer ties of friendship, whatever may have been the errors and misgivings of the past.

Mr. R. Borlase Matthews, M.I.E.E., said it had been his privilege from time to time to see these wonderful works under development. One of the things which had struck him about the way in which the contract had been carried out was that one of the first things which the contractors had done had been to build an electric generating station to supply current for the operation of the works from their own plant. The locomotives, except in the regions where there were explosives in constant use, were electric; the digging machines were electrically operated, and, in fact, everything on the plant which could possibly be electrically operated was so operated. That was a wonderful example of what was going to be the use of the current after the work was carried out.

A number of very serious difficulties had had to be overcome, which had possibly delayed the completion of the work by some six months. First of all, there had been the human element. Then there had been a serious and unexpected pocket of earth just underneath the foundations of the turbines. In quite a number of places, also, rock had been found where earth was expected, and earth had been found where rock was expected.

There was a very hackneyed saying that trade followed the Flag. He thought that could be paraphrased by saying that trade and industry also followed the supply of electricity. Agriculture was going to be one of the big users of electricity. He was satisfied that in most countries, including England, the agricultural load would eventually be bigger than the industrial load. People talked about the farmer being a small man, but quite forgot that in the aggregate he was the biggest worker on the face of the earth. Farmers had a strong business element; they did know what affected their pockets, but it was necessary for others to demonstrate to them the advantages of changes in their business. One of the biggest changes in farming in Ireland in the future would be electrical farming. The question was in how short a time that could be brought about. He had already heard rumours that model farms were going to be started, and he thought there could be no better propaganda than a series of model farms in different parts of the country where electricity was used in a reasonable and business-like way. Propaganda of that sort would help in showing how electricity could be used in agriculture, and would assist to bring back agriculture to its one-time prosperous condition.

Mr. Theodore Stevens, M.I.E.E., said he would like to know if the figures which were not in the paper, but which had been in the experts' report, and in the Siemens-Schuckert scheme, were the ones which were to apply to the manufacture of nitrogen compounds. The Siemens-Schuckert scheme talked about .35d. per unit. The experts' report thought that was too high, and they talked about .15d. He happened to know that carbide, which had to be made first before cyanamide was produced, was produced by the Alby Carbide Company in Norway when their current had been costing them 25s. per horse-power-year (0.05d. per unit). Could the present plant supply the lighting load for Dublin, and still have available power for the manufacture of nitrogen compounds? He would like to know if 150,000,000 units was the contemplated output from the plant in a year (that was the figure in the experts' report, 48,000 kilowatts was given as the peak load), and if one divided 150,000,000 by the number of hours in a year an average load was obtained of 17,000 kilowatts. There was not a lot left to be given to nitrogen compounds.

Captain Sir Arthur Clarke, K.B.E., said it was his pleasant duty to propose a vote of thanks to the lecturer for his most excellent and instructive address.

Personally he was not an electrician or a farmer; he was a seaman, and he would like to ask the lecturer whether the scheme was going to have any effect of any nature whatever on the lower reaches of the Shannon. He asked the question because some years ago there had been a great scheme to have a barrage at Gravesend, which he, as a seaman, had been against because he knew that if such a scheme were adopted the outer reaches of the Thames would be in a very short time like the outer reaches of the Dee—all sand banks. Fortunately that scheme had fallen through.

The Lecturer said that the Shannon scheme would not have any effect whatever on the lower reaches of the Shannon—the flow would of course be regulated.

Sir Arthur Clarke, continuing, said there had been a good deal said about Irishmen. He himself was an Irishman and he had listened with some indignation and with some very great pleasure to what had been said about the Irish. The Irishman was conservative, but not a bit more so than the Englishman. The Shannon Scheme, brought about by the energy and the vision of Irishmen, helped by other nationalities, would, he hoped, achieve successful results. It was vision that was wanted. In that connection he pointed to dock work. No dock in the world had ever been built big enough for the work which it had had to do a very few years after it had been constructed. He congratulated his countrymen on this great scheme, and wished it God speed for the benefit of the dear old country.

Lieut.-Col. V. A. Haddick remarked that he lived at Limerick, and therefore was very interested in what was happening at Ardnacrusha. The obvious thing to develop in Ireland was agriculture, because the wealth of Ireland lay in its agriculture. If electrical power could be used to develop agriculture, the day might come when exports from Ireland would go a very long way towards solving the food problem for the manufacturing millions of Great Britain. When the time came to form an Empire Ring of Dominion products and British manufactures, Ireland would not be found wanting.

The Chairman having seconded the vote of thanks, which was carried unanimously,

The Lecturer, in reply, thanked the members for the generous reception accorded to his paper and said he wished it were possible to deal with all the criticisms which had been made, but he feared that that was impossible, as these had been too numerous and had, indeed, sometimes wandered a little off the point. He agreed with Professor Wibberley that one of the effects of this great venture would be to electrify the minds of the people—although that would not be the only good thing it would do.

If he had not dealt with synthetic nitrogen, the audience would understand after Mr. Stevens' remarks why he had not done so. He had dealt with that subject in his previous paper before the Society, about seven years ago, on "The Power Resources of Ireland," and also frequently in papers published in the Journal of the Department of Agriculture. He was a great believer in synthetic nitrogen, but he was not quite sure that it was going to be manufactured by means of electricity from the Shannon Scheme. The question involved was that of the cost of electric power, and he did not quite see how they were going to compete with Norway in the matter. Moreover, he had a pet view that in

Ireland they would be getting nitrogen from peat probably before they got it from water. There were conditions in Ireland which were very favourable to the manufacture of calcium carbide and calcium cyanamide. On the peat bogs there were the three things necessary for the work: there was an excellent peat charcoal; there was the underlying limestone, and there was the peat as a source of power on the spot. But he had been anxious not to go into hypothetical questions. He had been dealing with hard facts. He believed that the Shannon Scheme would have the effect of introducing new industries in Ireland, but he was not prepared to say exactly what those would be. He was not at all sure as to the synthetic nitrogen. He was sorry he had not been able to deal more fully with the economics of the question. He could have become very diffuse about that topic. Neither had he given any exaggerated idea of the greatness of the Shannon Scheme. He had failed to use superlatives. The scheme was a great gesture, as had been said. He could not allow the suggestion to pass that the Irishman was naturally idle. He was not idle at all—not nearly so idle as he himself would be under the same circumstances. The real truth was that he had lacked opportunity. He was glad that Mr. Matthews thought that electrical power would be brought into use on the farm as a labour-saving device, but he did not think that the agricultural load would ever become bigger than the industrial load, as Mr. Matthews had suggested. He did, however, think it would have a very great effect on the future of agriculture in Ireland.

The meeting then terminated.

"DAILY MAIL" IDEAL HOME EXHIBITION.

For a brief period every year Olympia becomes the terrestrial paradise of our urban multitudes. Under its great roof, in an atmosphere which combines the ocular festiveness of a Christmas bazaar with the vocal delights of the cinema, are displayed all the elements, from the complete house down to the most insignificant gadget, which go to the making of the characteristic twentieth-century home. An immense fountain of water, irradiated with light, plays in the centre of the hall, while a loud-speaker, claimed to be the biggest in the world, utters the tunes of unseen organs and orchestras for all to hear—even for those who are trying out pianola pianos. Obedient queues wait with decently-concealed impatience outside the houses in the village of "Welcome In" till their turn comes. Wags go round to see what they can get for nothing in the way of samples. The penurious, controlling their wistfulness, invite obliging salesmen and saleswomen to put their ingenious wares through their paces.

In addition to the ruddy fruit and shining tins of preserved fish, etc., there is much food here for thought, for the reflective visitor. Does the press mould, or does it echo, public opinion? Is modern industrial design representative of those who demand or of those who supply? Did the first hen *lay* the first egg, or did it *come out* of the first egg?

I was struck by the good sense of the remarks made by various contributors to the guide-book to the exhibition. Their recommendations to the public are excellent. But the exhibition itself is no witness to the truths they set forth. The Enemy, disguised as half-timber—"this popular Tudor style"—and a high polish, lies everywhere in wait for the unsophisticated. Not that the village of "Welcome In" is all of this maudlin half-timber type. There is a cheap bungalow and there is a fairly expensive "Georgian" house, both of which are tolerable

outside and well-planned inside. It is a pity that in neither case should the interior decoration be unpretentious ; on the other hand, the heating and washing arrangements are neat and good, and these are at the root of the house-keeping problem. Indeed, several firms display the most attractive bathroom sets, while others have different variations of the geyser which appear adequate.

Passing on to furniture, I noticed one sound modern room which seemed to be puzzling the imagination of a part of the crowd. It is shown by the Arundell Display Company, Ltd., 54, Davies Street, W., and is designed by A. D. Maclaren. Here is a real modern style : ingenuity is shown, but ingenuity carefully bound up with form. A lady was heard to ask : " Why is the bed so low ? " One felt inclined to answer : " To save you looking underneath for burglars, Madam." A low bed, of course, saves space ; and Mr. Maclaren, by a judicious use of glass, as for a very attractive table, effectively lightens and brightens his room. The gunmetal-coloured covering of the chesterfield is admirable : the peculiar dressing-table, the drawers of which swing out instead of pulling, appeared amusing and convenient. The metal doors of a cupboard let into the wall are absolutely simple and in harmony with the general design.

Among the most insidious pieces of bad taste at Olympia are the elaborate fretwork pictures shown by a firm which, as I happen to know from personal experience, can turn out very good work. The pitiless exploitation of the grain of certain woods is the *reductio ad absurdum* of the tendency, of which we hear so much at the present time, to believe that materials can dictate the technique in which they are to be worked. In bad taste, too, are the diminutive grandfather clocks of which just now there is a foison. What rhyme or reason can there be in such an evolution ? Let us beware of the miniature : it is a sickly affectation.

The iron-workers of Borough Green, Kent, show a small but interesting and encouraging selection of firescreens, hinges, gates and latches. The note in the catalogue suggests that work of this kind is particularly suitable for " Tudor style of buildings " (again !), but, of course, the Kentish smiths are perfectly able to carry out modern designs.

Generally speaking, Olympia gives the impression that neither skill nor money are lacking in the industries represented, but that these are, on the whole, badly laid out owing to the lack of good taste, or of freedom to express good taste, among designers. A slogan that might be more true than most suggests itself: "where there is not taste there is waste." At any rate, if worthless novelties were dispensed with, time and energy would be saved ; for one has to go on thinking out novelties, while sound goods, once they begin selling, should continue to do so steadily or even with increasing momentum.

P. B.

NOTES ON BOOKS.

RATIONAL MECHANICS. By Lieut.-Col. Richard de Villamil, R.E. (ret.). London: E. and F. N. Spon, Ltd. 10*s*. 6*d*. net.

By " Rational Mechanics," Lieut.-Col. de Villamil does not mean " mécanique rationelle " ; he means mechanics consistent with reason. He considers that much of what is written by other authors is irrational and his object is to set them right. The book consists for the main part of quotations, some of which run to several pages, connected together with comments and statements of the author's own views ; the last few chapters contain a development of the author's treatment of shapes of least resistance. The hero is Newton, the subject of the dedication, but even he is respectfully criticised (p. 151).

The purpose of the author is a good one; the basis of academic mechanics is not always as sound as it might be and there is much in current text-books that may be usefully criticised. What he does not appreciate is that before we may criticise, we must fully understand the subject of our criticism. This failure leads him to put forward views that are not merely unorthodox, but sometimes uninformed, and to attribute elementary errors to eminent writers, without seeing how unlikely it is that they should commit them. He divides mechanics (p. 110, etc.) into dynamics, a deductive science, which is purely vectorial, and energetics, an inductive science, which is purely scalar. In dynamics we are not allowed to refer to energy in any form, although we may to *vis viva;* indeed the "conservation of *vis viva*" is one of its fundamental principles. In energetics we may not mention velocity, momentum or force. Such views as these provide Col. de Villamil with ample occasions for dissenting from other writers.

Glazebrook is severely censured (p. 34) for saying that the work U done by a force F when its point of application is displaced a distance s in the direction of its action is given by $U = Fs$. This we learn is equating scalars and vectors; the equation is not "homogeneous" and is meaningless. The author does not appear to have met with vectorial multiplication and we are spared his comments upon this equation, when the force and the displacement have different directions. Glazebrook suffers in good company. Sir J. J. Thomson (p. 163), the late Lord Rayleigh (p. 134, etc.) and Einstein (Ch. V), among many others, receive severe handling.

One example of the author's constructive work must suffice. Maxwell is commended (p. 115) for saying: "According to Poisson's theory of internal friction of fluids, a viscous fluid behaves as an elastic solid would do, if it were periodically liquified for an instant and solidified again." This image, according to Col. de Villamil, is to be taken as a literal fact. "From this argument," he says, "a very curious fact, which Poisson and Maxwell appear to have overlooked, follows logically; viz., that the generation of heat takes place in quanta. (I use the word "quanta" because it is the fashionable and learned expression which is generally employed). . . ." And the notion is developed at length.

Whatever may be said against the book, this may be said in its favour, that it contains an interesting collection of quotations, with ample references, and an index. Much care has been expended in its production; it is almost free from misprints and is excellently printed.

H.B.H.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 25..Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. The Hon. Sir Charles A. Parsons and J. Rosen, "Direct Generation of Alternating Current at High Voltages." At the University, Edmund Street, Birmingham. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Imperial Cash-on-Delivery Association, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Wing-Commdr. T. R. Cave-Browne-Cave, "Aircraft Engineering in its relation to Mechanical Engineering."

TUESDAY, MARCH 26..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. C. Lucas, "The Nature of the Colour of Pottery with special reference to that of Ancient Egypt."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

London Vegetarian Society, at the Royal Society of Arts, Adelphi, W.C. 6.45 p.m. and 8.15 p.m.

WEDNESDAY, MARCH 27..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. D. H. Little, "Roads."

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5 p.m. Mr. A. M. Hallawell, "Acoustics in relation to the Gramophone and Radio Loud-Speaker."

THURSDAY, MARCH 28..Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Dr. D. S. Anderson, "The Future Development of the Locomotive." (Joint Meeting with Institution of Locomotive Engineers).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

HISTORY OF THE ROYAL SOCIETY OF ARTS.

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15s. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

SIXTEENTH ORDINARY MEETING

WEDNESDAY, MARCH 20th, 1929. LIEUT.-COL. SIR ARNOLD T. WILSON K.C.I.E., C.S.I., C.M.G., D.S.O., in the Chair.

A paper on "Modern English Architecture," was read by PROFESSOR A. E. RICHARDSON, F.S.A., F.R.I.B.A., Professor of Architecture, University of London. The paper and discussion will be published in the *Journal* on May 24th.

DOMINIONS AND COLONIES SECTION.

TUESDAY, MARCH 26th, 1929. PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., Vice-President of the Institution of Mining and Metallurgy, in the Chair.

A paper on "The Base Metal and Mineral Resources of South Africa," was read by MR. H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa. The paper and discussion will be published in the *Journal* on May 31st.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, FEBRUARY 26TH, 1929.

SIR WILLIAM J. LARKE, K.B.E. (Director, National Federation of Iron and Steel Manufacturers) in the Chair.

The following paper was read :—

THE SOUTH AFRICAN IRON AND STEEL INDUSTRY: Its Development and Possibilities.

By H. J. VAN DER BŸL, Ph.D., M.Am.I.E.E., F.I.R.E., F.R.S.(S.A.), Chairman of the Electricity Supply Commission and the South African Iron and Steel Industrial Corporation, Ltd.

When the invitation was extended to me to read a paper before this Society on the Iron and Steel Industry of South Africa, it was considered, I understood, that a paper on this subject would be appropriate at this time, in view of the forthcoming meeting of the British Association for the Advancement of Science which is to be held in South Africa this year.

In accepting this invitation, which it gives me great pleasure to do, I must be modest enough to say that when I talk of the Iron and Steel Industry in South Africa, I am really talking of something that we hope is going to be, and therefore I may be excused if I dwell perhaps at greater length than would otherwise be justified on the more general economic conditions that must come into consideration in our efforts to establish the Iron and Steel Industry on a satisfactory footing.

On account of the pressure of my other work I am unfortunately not in a position to give accurate statistical details and supply the data that would make this lecture of more scientific interest, but I understand that a general survey of the position would serve the purpose.

Before discussing the possibilities of the Iron and Steel Industry in South Africa, it may be well to deal first with a more general question which is sometimes asked, namely, " why establish an Iron and Steel Industry in South Africa at all ? " Such a question may be asked in all good faith by people who look upon South Africa as a great mineral-producing country and a country of great agricultural protentialities, and that is because it is not generally recognised, except by those who live in South Africa and make a study of its resources, that South Africa in reality has an immense industrial future, and cannot develop solely as an agricultural and mining country.

The hectic days of the mining camps have long since passed out of the picture and people to-day come to South Africa to stay. Its climate is unexcelled, the amenities of civilisation are not lacking and the general conditions of living,

once people become accustomed to them, are appreciated and in fact become appealing.

At the present time a very large proportion of our agricultural and mining produce is exported. Intensive farming is comparatively speaking not highly developed; most farming is done on a large scale and is largely dependent on rainfall. Water conservation schemes have been embarked upon by the Government and by private interests, but the extent to which this can be carried out will depend in large measure on the extent of the farmers' home market. That there are great possibilities in this direction in the future is undoubted. The country lends itself very well, generally speaking, to water conservation, and I can foresee the time when large portions of the land will be covered by numbers of artificial lakes and dams. The rainfall in South Africa, on the whole, is high, but occurs during a comparatively few months in the year, and at present a very considerable portion of that water runs into the ocean.

As an example, it may be mentioned that the barrage on the Vaal river, which has been built to supply Johannesburg with water, impounds about 13,000 million gallons, and it happens that during summer so much water comes down the Vaal river that the dam could be filled thirty times over in one month. During the dry winter months, on the other hand, the flow is often so small that it would take, at that rate of flow, many years to fill the dam once.

I mention this merely as an example of what is characteristic in South Africa and to indicate that, although it is what may be called a dry country, ample water for cultivation and for industrial development can be obtained by storage.

Raw materials of almost every conceivable kind are obtainable in the country. South Africa can, therefore, support a very large agricultural and industrial population.

In contemplating our developments in South Africa we must often look to the distant future. We bear in mind that the Union has a hinterland of immense potential wealth, which becomes more habitable as civilisation marches northwards, and which is populated by great masses of human beings whose wants are increasing as they come more and more in contact with European civilisation. We look upon the Union of South Africa as the logical country to supply these people with a considerable proportion of their wants.

Taking the British Empire as a whole, one must be struck with the fact that such a large proportion of its peoples are either uncivilised or semi-civilised. It is therefore, from the point of view of material civilisation, in a relatively undeveloped state, and considering that the desire for civilisation of these peoples is becoming a collective consciousness, which is apparent even without particularly careful observation, one must conclude that the more highly industrially developed portions of the Empire will be called upon to an increasing extent to supply the growing wants of the masses now being born into civilisation.

In contemplating this trend of events two important phases manifest themselves. In the first place we can expect that there will take place a reorganisation and redistribution of the Empire's manufacturing activities. By force of economic laws manufacturing industries will spring up and develop in localities best suited in relation to the marketing possibilities and supply of raw materials. Goods are being manufactured in South Africa to-day which ten years ago it was economic only to import. But from this it does not follow that our imports have decreased; on the contrary, they have increased considerably. This was, of course, to be expected, because the greater the earning capacity of a people the greater their purchasing power; and the greater the industrial activity, in South Africa for example, becomes, the more the demand increases for the almost infinite list of the more highly manufactured commodities which for economic reasons we cannot manufacture and which must therefore be supplied from overseas.

Secondly, it is generally realised that a redistribution of population would be desirable if it could be accomplished. While the population of Europe has passed the economic density, the population of South Africa is so small as to be out of all proportion to the size and potential wealth of the country. The white population of the Union is to-day barely one and three-quarter millions. It must be admitted that to take merely the white population in considering the economic capacity of South Africa is misleading, because the coloured and native races also have a certain economic value, although it be on the average below that of white people. Taking the economic value of the coloured and native races, as producers and consumers, in relation to that of whites, and multiplying this ratio by their population and adding the resultant figure to the white population, I estimate that what may be termed the "equivalent white" population of the Union, is in the neighbourhood of four millions. The producing man power of the Union is therefore still very far below what it should be to be commensurate with the natural resources of the country. South Africa is therefore a country that should be able to take considerable numbers of emigrants from Europe. But with the present state of its industrial development it cannot risk taking in any considerable number of the type of people that Europe would care to let go. Europe, like most countries, prefers to retain its country people, and until South Africa is more highly developed industrially it cannot absorb in any large numbers the industrial people of Europe. The solution, therefore, seems to be that a redistribution of population can only take place concurrently with bigger industrial developments in the newer countries like South Africa.

The manufacturing industry in the Union has grown at an extraordinarily rapid rate during the past ten or fifteen years. While it was an almost negligible quantity some fifteen years ago, the manufacturing industrial output of the Union is now about twice as great as the total production of wealth through mining, including gold, diamonds and coal.

It is generally recognised that an Iron and Steel Industry forms a solid foundation on which a sound industrial structure of a country must rest, and the lack of a well-developed iron and steel industry in South Africa is recognised as a hamper to our progress. The engineering industry has developed to a fairly satisfactory state, but is still capable of considerable expansion. The making of iron and steel, on the other hand, is still confined to a very small scale.

An investigation into the economic possibility of an iron and steel industry has received the attention of the Government and private interests on and off for almost twenty years without so far having attained any marked degree of success.

In 1909 a report was made by Sir Robert N. Kotze (then Mr. R. N. Kotze), the Government mining engineer, in which he advocated the building of a blast furnace and steel plant on a moderate scale, with a view to developing the use of native ores for the production of steel. Large quantities of iron ore were known to exist at Pretoria.

In 1910 the Government of the Transvaal invited a British expert, Mr. Harbord, to investigate the matter further. Unfortunately Harbord's report was negative, and he recommended that, instead of starting a blast furnace plant, the smelting of the large quantities of scrap available from the railway works should be undertaken in electric furnaces. Harbord's principal objections were on the grounds that the ores in the Pretoria district were too highly silicious to give good results, and also that the home market was insufficient to absorb the production of an iron and steel plant large enough to work economically.

At that time the very considerable high-grade haematite deposits on the Crocodile river had not yet been discovered, but apart from that, important British steel makers apparently did not agree with Harbord's views, because, in 1910-11, one of the foremost British steelmakers started negotiations with the municipality of Pretoria to establish a blast furnace and steelworks plant on the Pretoria townlands.

About that time the Transvaal Government decided, as a result of the report of Harbord, to offer for sale the large quantities of scrap iron of the Railways, with a view to encouraging the starting of a steel industry. Tenders were called for and the late Mr. Samuel Marks was the successful tenderer. The consequence was that the above-mentioned negotiations with the Municipality of Pretoria were abandoned, as it was thought impossible to carry out this scheme unless large quantities of scrap iron were available.

Having secured the Government's scrap iron, Mr. S. Marks and some others started a small steel works at Vereeniging, which later on became what is now known as the Union Steel Corporation of South Africa, under the chairmanship of Major Aubrey Butler. It should be mentioned, however, that the Dunswart Iron and Steel Works, near Johannesburg, where scrap was worked up on a small scale, was then already in existence.

Until 1917 the only practical result, therefore, was the two small steel plants at Vereeniging and Dunswart, at both of which the raw material was scrap iron only. In that year Mr. C. F. Delfos formed a small company, the Pretoria Iron Mines, Ltd., for the purpose of testing the suitability of the Pretoria ores with a view to the establishment of an iron and steel works there. He built an experimental blast furnace of a capacity of 10 tons per day, with which 4,000 tons of satisfactory pig iron was produced. As flux he used dolomite, which occurs in very large quantities practically adjoining the iron ore deposits. The Pretoria ore contains on the average 48 per cent. of metallic iron, but is highly silicious. However, the experiment proved that with the Pretoria iron ore and the adjacent dolomite suitable pig iron could be made.

As Delfos and his associates were convinced that a steel industry could only be successful if modern plant of a sufficiently large capacity were installed, it was decided to form a company with a larger capital. The Pretoria Iron Mines, Ltd., was then taken over by the South African Iron and Steel Corporation, with a nominal capital of £1,500,000, of which, however, only £350,000 in cash was raised at that time. This amount was employed to investigate thoroughly the possibilities and resources of the industry and to acquire the necessary ore deposits, etc., the result being that the present enterprise now possesses some 150,000,000 tons of ore, of which two-thirds contain an average say 48 per cent. of metallic iron and one-third some 68 per cent. of metallic iron as also large coal fields, and practically unlimited quantities of dolomite, which is suitable as flux.

Meanwhile a parallel development was started by Mr. G. K. Eaton, who had been largely responsible for the establishment and successful career of the steelworks at Dunswart. Being convinced that for the true development of the industry it was necessary to have a pig iron basis he made arrangements for the erection of a small blast furnace at Newcastle, Natal.

In 1920 Delfos went to Europe to endeavour to raise further capital and to obtain technical advice. He engaged, as adviser, Mr. Ernest Bury, who was then General Works Manager of the Skinningrove Iron Works. Bury thoroughly investigated the raw materials, and in 1921 went to South Africa. He made an entirely favourable report both from the technical and the commercial points of view. His conclusions were that although the Pretoria ores were high in silica he anticipated no trouble in producing good steel from this ore.

The conclusions of Bury's report were investigated as regards the economic factors by an auditor of high standing in the steel industry, Sir W. B. Peat, and its technical conclusions were submitted to the late Dr. Stead, then President of the Iron and Steel Institute, who consulted with Harbord. These experts corroborated Bury's finding both from the economic and technical points of view. Assurance of the technical and economic feasibility of the

undertaking having thus been obtained, it was now only necessary to raise sufficient capital. This, however, proved to be the real stumbling block.

The first attempt to raise capital was made in 1920, when the assistance of the Trade Facilities Advisory Board was asked for. This body, however, required guarantees from the South African Government which the latter was not prepared to give.

Although the exploration by Delfos of all other avenues of obtaining capital in Great Britian failed, it nevertheless resulted in negotiations with a prominent British iron and steel concern with a view to their participation in the establishment of an iron and steel works in South Africa.

It was realised that there was room for only one such works in South Africa, and the negotiations led to a provisional amalgamation of the three principal interests, namely, the Union Steel Corporation, the South African Iron and Steel Corporation, and the Newcastle Iron Works. The most important stipulation of this amalgamation was that sufficient capital must be raised to carry out the programme.

Towards the end of 1920 I returned to South Africa as Technical Adviser to the Government on industrial matters. After making a study of the economic conditions in South Africa I came to the conclusion that the industrial development which the country had attained lacked the proper foundation which, as it seemed to me, only an iron and steel industry could furnish. After discussions which I had with General Smuts, then Prime Minister, it was decided to encourage this industry with the help of bounties on the production of iron and steel from South African ores. The maximum value of the bounties amounted to fifteen shillings per ton of pig iron and an equal amount per ton of steel, a condition being that the capacity of the works should be at least 50,000 tons per year. The Bounty Act was passed by Parliament in 1922. As a result, the Trade Facilities Advisory Board was again approached, but without success. Other attempts to get the undertaking financed in London also fell through, because of unsatisfactory terms, and further efforts to obtain capital in Great Britain were then abandoned. Thereupon the South African Iron and Steel Corporation withdrew from the amalgamation.

In 1923, General Smuts, who was then in power, instructed the Union Trade Commissioner on the Continent to make enquiries whether other interests could be induced to start a steel industry in the Union. As a result of these enquiries the Government received an offer from the Gutehoffnungshuette to send out a technical commission to South Africa and, should the result of its investigations be favourable, to build and finance the enterprise in conjunction with British, Dutch, and German financial interests. The Government approved of this suggestion and put the Gutehoffnungshuette into touch with the South African Iron and Steel Corporation.

The technical commission came to South Africa early in 1924 and thoroughly investigated the whole question. Their report was entirely favourable, and it

was recommended that a plant capable of producing 132,000 long tons of finished steel should be put up at Pretoria, this being the most favourable site from all points of view.

The industry would undoubtedly have been established at that time, but unfortunately the occupation of the Ruhr made it impossible for the Gutehoffnungshuette and its associates to undertake the financing of the scheme.

It was then considered impossible to raise sufficient capital from private sources, and towards the end of 1925 Delfos made a proposal to the Union Government that they should support the Steel Industry financially, with a view to the formation of a semi-public Company.

In the meantime the Newcastle concern was absorbed by the Union Steel Corporation, the arrangement being that pig iron made at Newcastle should be taken to the works of the Union Steel Corporation at Vereeniging, some two hundred miles away, to be made into steel. The blast furnace at Newcastle which was started by Eaton was completed and blown in in 1925.

Two years ago the Union Steel Corporation claimed bounties for its production of iron at Newcastle, but the Government, not being satisfied that the capacity clause of the Act had been complied with, refused to pay the bounties. The matter went to court, which gave a decision in favour of the Company, but on appeal the decision was reversed. This unfortunate incident has caused a certain amount of bitterness, and therefore I do not regard the present occasion as appropriate for doing more than merely making brief mention of the occurrence, especially as I had no connection with it and therefore cannot speak with authority on the matter.

Last year Messrs. Stewarts and Lloyds erected a modern tube factory at Vereeniging. The steel industry at Vereeniging now comprises a steel works, where steel is made from scrap and Newcastle pig in open hearth and electric furnaces, the products being rails up to 60 lbs., the smaller sections and merchants' requirements, tube billets for the tube works of Stewarts and Lloyds, steel castings and forgings ; a wire works for the manufacture of plain and barbed wire and the above-mentioned tube works.

The Government authorities were not convinced that the amalgamation of the steel works at Vereeniging and the iron works at Newcastle was sufficiently sound economically to develop into an iron and steel industry on the national scale that was desired, and it consequently sought legislative powers to establish an iron and steel company roughly on the lines of the Electricity Supply Commission which was formed in 1923.

The Iron and Steel Bill was passed by Parliament in 1927, but was rejected by the Senate, whereupon in 1928 the Government called a joint session of both Houses at which the measure was passed. This resulted in the establishment of the South African Iron and Steel Industrial Corporation, Ltd., and arrangements were made for this new concern to absorb the South African Iron and Steel Corporation.

Although the measure was strongly contested there was little difference of opinion as to the desirability of encouraging the establishment of the iron and steel industry on a reasonably large scale. The difference of opinion lay largely in the manner in which it was proposed that the Company should be constituted, objections being raised to the Government retaining the control, while on the other hand it was held that the constitution of a company more or less on the lines of the Electricity Supply Commission was justified by the success of the latter.

Both the Commission and the South African Iron and Steel Industrial Corporation are in the nature of their constitution a departure from the ordinary. The Commission was established by the Government in 1923 in recognition of the great value of electric power in the industrial and economic life of the people, and because electric power is regarded as a prime factor in industry, the production of which should be encouraged for the benefit of industry generally rather than with a view to making profits. In the establishment of the Commission a genuine attempt was made to combine the advantages of both Government ownership and private enterprise.

The Commission is not a Government Department, but a body corporate in law and is established by Act of Parliament. All Commissioners are appointed by the Government, but their remuneration is not paid by the Government but by the Commission itself. Neither the Commissioners nor any of the Commission's employees are civil servants. The Commission is, in fact, free to operate in every respect like a private concern, the only real difference being that it must, generally speaking, be a non-profit-making concern; all surplus after meeting capital charges must go to reduction of the price of electricity.

A material advantage enjoyed by the Commission lies in the financial assistance afforded by the Government, the latter having undertaken to finance the Commission during the first seven years of its existence, that is, during the period when it would be difficult to obtain money from the public. The money loaned by the Government is a liability against the assets and revenues of the Commission.

The Commission now owns four steam power stations and one small hydro-electric power station, of a total installed capacity of nearly 300,000 h.p.; its capital commitments are about £8,000,000, while this year I expect that the sales will amount to about 800 million kilowatt hours of energy from the Commission's power plants.

The success of the Commission is due largely to the nature of its constitution. Had it been a Government department it would not have been possible for it to grow in less than six years from nothing to one of the largest power supply concerns in the Empire. On the other hand, had it not been for the financial assistance afforded by the Government it would not have been possible for us to sell electricity at the low rates obtaining to-day.

I may be excused for dwelling at some length on the Electricity Supply Commission, but it is necessary because of the close analogy between it and the newly-formed South African Iron and Steel Industrial Corporation. This Corporation is also constituted by Act of Parliament and is a duly registered company. Out of a total directorate of seven, the Government appoints four directors, including the Chairman, who has a casting as well as a deliberative voet.

Its authorised share capital is £3,500,000, and it is also empowered to issue debentures to the amount of £1,500,000, thus making a total capital of £5,000,000. By the Act the Government is authorised to subscribe £500,000 out of the £3,500,000 share capital and to guarantee the one and a half million debentures in respect of both interest and principal. Besides this guarantee these debentures must also be backed by assets of the Corporation. The Corporation is therefore sure of £2,000,000. The rest of the capital required must be obtained from the public.

The debentures are to pay interest at a rate not exceeding 5½ per cent. Considering the Government guarantee of the debentures and their lien on the assets of the Corporation, these debentures should be a very sound investment, and therefore a sufficient margin is allowed in the maximum interest provided for by the Act.

Of the shares, those taken up by the Government (A shares) and those to be issued to the public (B shares) share in dividend *pari passu* up to six per cent., which is the maximum dividend payable on the Government or A shares. Thereafter the public or B shares get the rest of the profit up to a maximum dividend of 12½ per cent. Any surplus that may remain after appropriation of profits in the above-mentioned manner may be applied by the Board, in such manner as it may in its discretion deem practicable, to the reduction of the price of iron and steel.

The capital of the Corporation may, with the approval of the Governor General, be increased by 500,000 ordinary B shares of £1 each.

The Board is empowered, but with the approval of the Minister in charge of the Act, to offer to the public preference shares, cumulative or otherwise, in lieu of any number of ordinary B shares, and the Board may acquire, without Ministerial approval, rights and property for payment in B shares, and is empowered to withhold the equivalent number of shares from public issue.

The debenture issue can be made at such time and amounts as may be suitable, but only with the approval of the Governor General, and a sinking fund must be established to redeem the debentures in not more than forty years. The Board, however, has power to buy the debentures in the open market and cancel them. In case the Government be called upon to meet the guarantee on the debentures, such disbursement from the Government's Consolidated Revenue Fund, together with interest at the rate of 5½ per cent., must, according to the Act, be a second charge on the assets and revenue of the Corporation.

The Board is furthermore empowered to borrow from time to time in anticipation of the issue of any shares or debentures up to the amount of such proposed issue ; it may also borrow additional sums, but then only with the approval of the Governor General, the limitation to such borrowing being one million pounds. Interest on any debenture issue during construction may be charged to capital account.

The books of the Corporation are to be audited by two auditors, a condition being that they must be persons who publicly carry on the profession of accountants. One of the auditors must be appointed on the nomination of the Minister, and the other on the nomination of the holders of B shares.

It will be seen, therefore, that where actions of the Board require approval of the Government, or the Minister, it is for the protection of investors.

The Government retains ultimate control through a provision of the Act which stipulates that although the Government buys only half a million pounds' worth of shares it shall have one more vote than the total number of votes which all the other shareholders of the Corporation may be entitled to in respect of the shares they hold. Furthermore, the Corporation cannot be wound up without the authority of an Act of Parliament.

This control does not, however, imply interference on the part of the Government in the affairs of the Corporation. The Electricity Supply Commission, as stated above, is a similar body. It has been in existence now for almost six years, during which time two different Governments have been in power, and as I have been chairman of the Commission since its inception, I can say with authority that I have never experienced the slightest Government interference in the affairs of the Commission, and the Government has given an undertaking in Parliament to follow the same policy in regard to the Steel Corporation. This policy of no political interference is becoming a tradition with us. The measure of Government control that exists is for the protection of the investors and for the benefit of the country.

As to the objects and powers of the Corporation, these are, as in the case of the Electricity Supply Commission, very wide indeed. They are as follows :—

(*a*) To carry on the trades or businesses of iron masters, steelmakers, steel converters, colliery proprietors, coke manufacturers, miners, smelters, engineers and iron founders in all their respective branches, and to manufacture, manipulate, buy, sell, exchange and otherwise deal in iron and steel ;

(*b*) To purchase or otherwise acquire, as a going concern, all or any part of the business, property and liabilities of any person or company carrying on any trade or business which the Corporation is authorised to carry on, and to carry on, abandon, dispose of or otherwise deal with any trade business so acquired.

(*c*) To search for, win, quarry, reduce, smelt, refine and prepare for market iron ore or any other mineral capable of use in the production or treatment of iron and steel.

(*d*) To apply for, purchase or otherwise acquire any patents, licences, concessions or the like, conferring an exclusive or non-exclusive or limited right to use any information or process which may seem to the Corporation capable

of being used for any of its purposes, or the acquisition of which may seem to the Corporation calculated, directly or indirectly, to benefit the Corporation, and to use, exercise, develop, grant licences in respect of, or otherwise turn to account the property, rights and information so acquired.

(*e*) To acquire and take over rights and liabilities under any control relating to the production or treatment of iron or steel or any other mineral capable of use in the production or treatment of iron or steel.

(*f*) To investigate and prospect with a view to the discovery of deposits of iron ore or any other mineral capable of use in the production or treatment of iron or steel, and to enter into options, contracts and other arrangements for the acquisition of rights to prospect, open up and mine such ore or any such minerals.

(*g*) To take or otherwise acquire and hold shares or stock or securities in any company having objects wholly or in part similar to those of the Corporation.

(*h*) To sell, exchange, lease, mortgage, dispose of, turn to account or otherwise deal with any assets of the Corporation, or any part thereof, or any part of its property, whether movable or immovable, not required for the purposes of the Corporation, for such consideration as the Corporation may think fit, and in particular for shares or debentures, debenture stock or other securities of any company having objects altogether or in part similar to those of the Corporation ; and

(*i*) To purchase and sell coal or fuel, steam, water and other materials and stores, and manufacture and sell by-products.

In connection with the attainment of any objects of the Corporation referred to above, the Corporation may—

(*a*) Purchase, take on lease or in exchange, hire or otherwise acquire any movable or immovable property, claims, mineral properties, mining rights, water and other rights of every description within the Union, and any interests therein and rights over the same, and any concessions, grants, rights, powers and privileges in respect thereof, and may act as aforesaid either solely or jointly with others ; and

(*b*) Carry out, establish, construct, maintain, alter, improve, manage, work, control and superintend any roads, ways, railways other than for the conveyance of public traffic, bridges, reservoirs, water courses, pipe lines, embankments, hydraulic works, electrical works and chemical works, telephones, smelting works, furnaces, factories, warehouses and other buildings, works and conveniences, and contribute to or assist in the carrying out, establishment, construction, maintenance, alteration, improvement, management, working, control or superintendence thereof : provided that any railway sidings constructed and worked under the provisions of this sub-section, and connected with the lines of the South African Railways and Harbours Administration shall be subject to such regulations as have been or may be promulgated under the Railways and Harbours Regulation, Control and Management Act (Act No. 22 of 1916), or any amendment thereof, in respect of private sidings.

The Corporation may further do all such other things as are incidental or conducive to the attainment of any object or incidental to any powers or functions mentioned in this section, or which are calculated directly or indirectly to enhance the value of or render profitable any of the Corporation's undertakings, property or rights.

These wide powers given to the Corporation caused the Board to be faced at the outset with a very important question of policy, namely, the scope of operations that we should aim at. My interpretation of the Government's policy which put the Iron and Steel Industry Act on the statute book is that it was not the intention to bring into being and assist financially a powerful corporation for the purpose of competing with existing industries in the country, but, firstly, to contribute in a very substantial measure towards building the foundation of our engineering and other industries by the establishment of the basic industry, namely, the manufacture of iron and steel, in recognition of the experience that the manufacture of iron and steel in a country has a powerful influence in stimulating industrial growth generally, and, secondly, to ensure the development of subsidiary industries should private enterprise fail to follow in the wake. We therefore decided as a fundamental principle of our policy to confine our efforts, as far as practicable, to the production of primary steel products, such as rails, sleepers, building sections, sheet bars, light plate, billets, ordinary merchant requirements, and reinforcement and wire rod, believing that where opportunity offers for the development of subsidiary industries private enterprise will not fail to seize it. We are of opinion that the best results will be obtained by working amicably together with subsidiary and cognate industries and by encouraging the establishment of further subsidiary industries. It will certainly redound more to the benefit of the Steel Corporation if our efforts are directed towards assisting capital which has been invested in such industries to earn more and so to encourage further development. Thus, although the Corporation has secured coalfields, it would be wiser to purchase coal from existing collieries as long as satisfactory terms can be obtained rather than sink more capital into new collieries for the sake of mining our own coal. It will be seen that I keep in sight the national aspect, which, especially in a country like South Africa, it is very important to do. The iron and steel industry can only prosper with the general prosperity of the country, and, while this is generally true of many other industries, in the case of iron and steel this truth looms up with much greater reality because of the basic nature of the iron and steel industry. One of the best means of encouraging prosperity generally is to enable already invested capital to increase its earnings and to guide industrial development in such a manner as to avoid as far as possible fruitless duplication of capital expenditure.

As a result of this general policy, we have laid the foundation of an amicable working agreement with the Union Steel Corporation whose works are at Vereeniging and Newcastle. With this, it is hoped, the conflict of steel interests, which existed for years, has now come to an end.

As regards the technical and commercial possibilities of the undertaking our investigations give reason to be hopeful of success.

It is proposed to establish the iron and steel works at Pretoria. The ore

deposits which influenced Mr. Delfos some twelve years ago to erect the experimental blast furnace mentioned above occur mostly on the Pretoria townlands some four miles from the centre of the town.

The Corporation has a 99 year agreement with the Pretoria town council, whereby the site for the iron and steel works is obtained free of cost, and the ore can be mined at a royalty of £500 per annum or 2d. (two pence) per ton, whichever is the greater. Provision is also made for the supply of water by the town council on favourable terms.

The Pretoria ore quantities are estimated to be about one hundred million tons of silicious haematite, yielding about 48 per cent. metallic iron and about nine million tons of claybound ore averaging 54 per cent. metallic iron.

For many years the silicious ore will be quarried in the hillside adjoining the works. Other iron ore resources include a deposit of roughly fifty million tons of extremely pure haematite of about 68 per cent. iron. This deposit occurs on the Crocodile river about 115 miles north of Pretoria and for many years can be obtained by quarrying and adit mining.

The coal resources of the Union of South Africa are estimated at about 250 thousand million tons. The coal occurs mostly in the Eastern Transvaal and Natal. The Natal deposits contain several seams of excellent coking coal and is comparatively easily mined, but the distance of these coal mines is over 200 miles from Pretoria. The Transvaal coal mines (in the Witbank area) are about 60 miles from Pretoria on the Pretoria-Delagoa Bay main line, and while this coal does not appear to have the same good coking qualities as the Natal coal it is nevertheless possible that the whole or at least a very considerable proportion of the coal required for the steel works will be drawn from the Transvaal coal fields.

The dolomite required for the blast furnaces occurs in very large quantities a few miles from the site and will be brought to the works on a ropeway, while lime for the steel furnaces is also obtainable in the Transvaal.

It is proposed to lay out the works for an initial annual production of about 150,000 tons of steel. This would be about half of the importations of the materials we propose to make. It is our intention to design the works in such a manner as to be capable of easy extension, because once successful, we can expect it to grow rapidly if it is to keep pace with the general economic growth of the country.

In this connection I may mention that the total exports of the Union during the past five years have increased by 75 per cent. This gives an indication of the growth of the country's trade.

DISCUSSION.

The Chairman, in opening the discussion, said that one thing which had particularly struck him had been that the lecturer was approaching his great responsibilities with a very high sense of industrial statesmanship ; he had said

that the iron and steel industries could only prosper with the general prosperity of the country, and had also pointed out that the iron and steel industry was the foundation stone of a modern industrial community. It was, indeed, his personal opinion that an industrially prosperous country was only possible if it had an efficient iron and steel industry. In establishing an iron and steel industry in South Africa the lecturer would, he was sure, not force the pace so fast, that the prosperity of that great country, with its most wonderful resources yet untapped, was affected or delayed by reason of the fact that the materials necessary for development, in the form of iron and steel products, were not available at an economic price level. Mistakes like that had been made in other parts of the world, which had not only had a very detrimental effect on the territories themselves, but also on the development of mutual trade within the Empire.

As representing, in some sense, the British iron and steel industry, he might be permitted to say that that industry followed the development which had been outlined that afternoon with the greatest sympathy, and in a spirit of the closest co-operation, which the South African iron and steel industry would permit. They did not look on these developments within the Dominions as in any sense competitive, although they might ultimately or immediately reduce to some extent the demands made upon their productive capacity. Taking the long view, he was confident that such developments would increase the demands, ultimately, which the Dominions would make on British industrial products, and even on the products of the British iron and steel industry itself. So long as the views which the lecturer had expressed so ably and eloquently that afternoon governed the industrial policy of South Africa with regard to her iron and steel industry, then he was confident that the development of South Africa would not be retarded by the foundation of that industry, but would be accelerated. He would like to assure the lecturer that he had only to indicate to the British industry any way in which which they could co-operate, and he was confident, speaking for them, that that co-operation would be forthcoming. Personally, he looked on industries of a like kind developed throughout the Empire as having like interests, and he hoped that the British industry would always treat their development as being one of absolutely common interest and developing a common market to each other's mutual advantage. It would be noted that the exports of South Africa had increased 75 per cent. in the last five years. Where did they go to? Seventy per cent. came to this country. South Africa being in the family, as it were, all would contribute as much as lay within their power to the development of her resources, believing that in so doing they were also serving their own best interests.

MR. F. W. HARBORD, C.B.E. (Past President of the Iron and Steel Institute), said they all greatly appreciated the opportunity of hearing a lecture which had given so much information on the recent discoveries of raw materials, and the present economic position of the iron and steel industry in South Africa. It had been his privilege to visit South Africa about eighteen years ago to report to the then Transvaal Government on the possibility of starting an iron and steel industry there. An iron and steel industry, or any other industry, depended for its success mainly upon two things—firstly, control of adequate supplies of suitable raw materials at a reasonable price, and, secondly, a market for the finished products. Eighteen years ago there were undoubtedly raw materials in South Africa from which pig iron could be made, but he had been forced to the conclusion, after most careful consideration, that the market in those days was not sufficient to enable a steel works to be operated at anything like its full capacity, and consequently

the erection of a large steel plant was not then justified. Nearly twenty years, however, was a long time in the life of a country and great progress had been made in South Africa during that period. He understood that the imports of the whole of the Cape had trebled during the last eighteen years, and that new deposits of iron ore, relatively low in silica and easily reducible, had been discovered quite near Pretoria. A new deposit of coking coal had also been discovered, and the use of dolomite, of which there were large quantities in South Africa, as a flux had been shown to give perfectly satisfactory results in the manufacture of pig iron in various parts of the world. Therefore, to-day, conditions were totally different to those prevailing eighteen years ago, and he believed the time had now come when an iron and steel industry could be successfully started in South Africa, provided a plant of moderate size were installed, and gradually increased as the demand for its products increased. South Africa enjoyed the natural protection for iron and steel products of a long sea freight and for the Transvaal and the rapidly-developing country to the North a railway freight of 600 miles, and these, apart from any bounty or assistance which might be given by the Government, formed a great natural protection to the market. The country generally was developing rapidly, and there was a great and increasing demand for many of the finished products of the iron and steel industry. Under those conditions it seemed to him that the only thing South Africa could do was to try to develop her own iron and steel industry, and he looked forward to seeing an industry successfully established in the near future.

Before closing he would like to refer to the pioneer work done by Mr. Delfos, and express his appreciation of the indomitable pluck and perseverance he had shown, extending over many years. It was undoubtedly largely due to his untiring efforts that South Africa had decided to establish an iron and steel industry.

Mr. J. C. Fraser mentioned that he had been connected with South Africa for fifty years and could therefore claim to speak with a certain amount of authority on the questions which the lecturer had brought before the meeting that afternoon. He had attended in order to get information as to where this gigantic State monopoly was to find an outlet for its manufactured goods. The lecturer had made one or two statements with which he entirely disagreed. The first one was that South Africa was bound to be a good agricultural country. One only had to study the history of the last twenty-five years, during which time agriculture had had the best possible care bestowed upon it by all the Governments which had been in power, to admit that the future of South Africa, as far as the Union was concerned, did not lie in agriculture. If South Africa was not going to be an agricultural country, where was the outlet going to be found for the products of this proposed industry? Something had been said about the huge development of industry in South Africa of late years. It was quite true that the country had gone ahead wonderfully, but it had done so behind the shelter of high tariffs which had been put on practically everything coming into the country. In his opinion a great market for the products of an iron and steel industry in South Africa was merely a dream. As far as he could see, the great future for South Africa lay in the development of its minerals. If half the stories were true as to the wealth of Rhodesia in copper, they were going to "lick creation." The lecturer had entirely failed to state where the markets for his iron and steel industry were going to be found.

He contested entirely the lecturer's idea of assessing, as he had done, the value of the black population. There was a mere handful of white people in South Africa

to-day; the Union contained 1,750,000 white people. What a market for which to start an iron and steel industry! Was there any chance of the black people being any good for the purpose? There was none, as the whole policy of the Government at the present time was to keep the black man from earning money; they were anxious to segregate him, and how could any efficient demand be hoped for from poor people like that? The truth of the matter was that the whole of the labour and social policy of the Union to-day was founded on the black man's cheap labour, and as for an iron and steel industry being of any use to the natives, he could not see it at all. What he would like the audience to clearly understand was that the project was going to be a State venture. A great number of people in South Africa did not believe in State manufacture. They had seen a good deal of it during the last ten years, and the more they saw of it the less they liked it.

Sir Benjamin Morgan (Chairman, British Empire Producers' Organisation), remarked that there had been a good deal of criticism of the project under discussion, but personally he was convinced that a steel industry could be successfully established in South Africa. He had known South Africa fairly intimately for about twenty-five years, and he thought that, providing the industry did not spread itself over too wide a field, it could engage in steel manufacture with great success. Personally, he believed that Empire development would proceed very much quicker than it had in the past if all concerned co-operated in the distribution of industries throughout the Empire. For instance, if South Africa said to Great Britain: "You co-operate with us to found this industry, limiting it to certain kinds of products, and we, in our tariff, will give you a substantial preference in all the other ranges of steel products," far more business would be done with South Africa than was done to-day. The right policy for the Dominions was to produce certain commodities which they could economically produce, and it would be the right policy for this country to support the Dominion's efforts to found those basic industries in their own countries.

He had been very much surprised at the gloomy picture which the last speaker had painted as to the development of industries in South Africa. As a matter of fact, the South African primary industries were going ahead very rapidly. For instance, the export of sugar from Natal to this country had grown from 5,000 tons four years ago to 75,000 tons this year. The wine, fruit and wool industries were expanding in the same way. That was a very promising feature in relation to the establishment of an iron and steel industry in South Africa. The only thing he would like to be sure about was that that industry would come to this country and not go elsewhere for technical guidance and co-operation. It would get better value for its money here than in any other country.

Mr. C. F. Delfos said the impression he had gained from Mr. Fraser's speech was that Mr. Fraser was absolutely misinformed about the position. There was no doubt that South Africa had an entirely sufficient market for the material which it was intended to produce from its iron and steel works. The position was a very good one. Pretoria was inland, and there was a great protection afforded by reason of the distance from other iron and steel producing countries. There was no doubt that the market was there. For instance, there was a demand for 60,000 tons of wire per year in South Africa; in corrugated galvanised sheets there was a demand for 63,000 tons, and for steel rails and sleepers there was a demand for about 100,000 tons. In other sections the demand was also large. South Africa for the next one or two generations would not be a true industrial

country in the sense in which that was understood here, but if she could start to produce her raw materials in such a way as to develop the country, the buying power of the population would become very much greater, and the effect would be that a very much greater quantity of goods would be sold. He was afraid that Mr. Fraser did not know what the true position was. Success would follow the venture, which had been described in the paper, under the able guidance of the lecturer.

Mr. Frank Cooper said that, speaking as one who some years ago had had the good fortune to be associated with Mr. Delfos in his investigations, he would like to point out that one phase of the matter had not been touched upon—owing no doubt to the modesty of the lecturer and of Mr. Delfos. Those gentlemen had remarked on the length of time that the scheme had been under consideration, but they had not said anything about the immense amount of labour and thought which they had put into the project. He had worked with Mr. Delfos for several years, and had been amazed at the amount of care and thought with which he had examined every item of the scheme. By now the lecturer and Mr. Delfos must be walking encyclopædias of everything that had happened or was happening in the iron and steel industry of the world, and when the proposed plant was opened he was perfectly satisfied that it would not only be a credit to South Africa but a credit to the Empire.

Mr. A. K. Reese stated that he had had some experience in connection with the iron and steel industry in South Africa in connection with the Union Steel Corporation, and from the technical side of the matter he could fully confirm everything which the lecturer and Mr. Delfos had said. The country had resources which were eminently suitable for the manufacture of best qualities of iron and steel. There was an abundance of good iron ore and good coking coal in the country, and there was no reason at all why the industry should not develop and be the basis of the establishment of other important industries. The only precaution which had to be taken was to see that at the start a too large industry was not established which would choke itself with over-production, but that point could be safely left to the lecturer, to Mr. Delfos and to others interested.

Mr. E. J. Fox said he had attended the meeting as a slight compliment to Mr. Delfos, to whom the greatest thanks were due for the extraordinary perseverance he had brought to bear on the subject, extending over so many years. It was unquestionably the bounden duty of South Africa, with the immense mineral resources which she had available, to develop those resources. South Africa had labour and minerals, and could anyone blame her if she employed her labour in the development of her own minerals ?

Dr. J. A. L. Henderson said that the subject was one which had occupied a good deal of his time some thirty years ago on behalf of the late Mr. J. C. A. Henderson, who was an enthusiastic believer in the possibility of establishing an iron and steel industry in South Africa. Much money was spent on the investigation of various iron ore deposits, limestones and dolomites ; the coking qualities of the coals, water supplies, and the markets for iron and steel products ; but, unfortunately, for the reasons adduced by Mr. Harbord, the consensus of expert opinion which had been obtained in England and elsewhere, justly negatived the possibility of success in those days. It was, therefore, with great interest that he

had heard that afternoon not only of the recent rapid expansion of South Africa's industries, and of its power of consumption of iron and steel products, but of the figures which had been given with regard to the effective employment of the dolomites as fluxes, which had seemed to offer an insuperable obstacle thirty years ago, and also the profitable utilisation of the abundant titaniferous iron ores which had also been considered to be unsuitable for the purpose in past days.

The chief criticism, which many made in regard to a project of the nature under discussion, was as to whether the form of direct Government association with an industry was the best one under the circumstances. Many favoured a bounty rather than such an association. He had been interested in noting the struggling position of the iron and steel industry in Nova Scotia, Canada, where there was access to abundant supplies of excellent iron ore, with plentiful and suitable limestone and good coking coal in the immediate neighbourhood ; and one wondered how the South African industry would eventually work itself out.

In view of the great advantages which would accrue to South Africa from its success, the progress would be followed with keen and sympathetic interest.

Lieut.-Colonel Alan Dore, D.S.O. (Director, Messrs. Baldwins, Ltd.), said he had recently returned from South Africa, where he had heard people talking about the project described in the paper. A good many were in favour of it, and a good many were against it. One of the things he had heard said was that if the country produced 150,000 tons of steel out of the 300,000 tons imported, it would have to make everything practically from twist drills to bicycles, and it was argued that that would not be cheap production, as only a few tons of one article and a few tons of another would be made, and consequently the cost of production would be very high. Another criticism which had been passed was that there was no water in Pretoria. The most serious objection he had heard was that the project would be a State monopoly.

The Lecturer, in reply, dealing with the point of manufacturing 150,000 tons of steel when the importation was only 300,000 tons, said that what the proposed works were going to make was not 50 per cent. of electrical machinery, needles, drills, and so on, but 50 per cent. of the present importation of 300,000 tons of rails, sleepers, building sections, galvanised sheets, wire, reinforcement rod and so on. They were only going to make 150,000 tons of those things. The whole question of markets, production and economic output had been thoroughly gone into. They would not have to look for a market. It was there. The country did not stand still. By the time the works would have reached the producing stage, say, three years hence, the present figure of importation would probably have gone up by 40 per cent., which would make it still more easy for the works to dispose of its proposed production of 50 per cent. of the present importation.

With regard to water in Pretoria, that had been a difficult problem. It was not so much a question of no water as of too much water. But the water was to be supplied by the Pretoria Town Council, who had got out several schemes, and their only difficulty was to decide which one to adopt. He anticipated no difficulty in getting all the water required for an iron and steel industry. With regard to the question of State monopoly, he had dealt with that in the paper. He appreciated very much indeed the remarks which had been made about co-operation. It was really one of the most important, if not the most important, question which faced them that they should not try to cut each other's throats and that they should not try to make more than they could absorb. It was necessary to feel the way,

and that was exactly what they proposed to do. South Africa wanted Great Britain to understand what she firmly believed, that the development of an iron and steel industry in South Africa was going to redound to the benefit of the industries in England. There was no doubt about it. Affluence would come to the people of South Africa, and they would consequently buy more goods. Although South Africa manufactured now more than they did ten years ago she still imported more; she was one of Great Britain's best customers. It was his earnest desire to co-operate with this country, and he did appreciate very much the fact which had been expressed that afternoon that this country, too, desired to co-operate with South Africa.

Major Sir Humphrey Leggett, R.E., D.S.O., in proposing a very hearty vote of thanks to Sir William Larke for presiding, and to the lecturer for his extremely interesting lecture, said if there was one impression more than another which had been left on the mind of a layman like himself as a result of the meeting it was that the lecturer had put the position with such extreme frankness that it was bound to remove any misconceptions which had been prevalent in this country, and was an indication of the way in which the South African Government and those responsible intended to carry out this great project. They were carrying it out in the light of day. There was nothing so dangerous as the growth of a spirit of distrust and the feeling that there was some political motive behind a matter which should be purely industrial. Nothing could be more typical of the spirit in which the whole matter was being approached on both sides of the water than that there should be on the same platform at the same time two men like the lecturer and Sir William Larke offering co-operation to each other in the most obviously sincere manner, and desiring to work not only for the good of their respective countries and of the British Empire, but for one of the greatest industries of the world.

The vote of thanks was carried unanimously, and the meeting terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Tuesday, April 2..Transport, Institute of, at the University, Bristol. 5.40 p.m. Annual General Meeting.

Wednesday, April 3..Analysts, Society of Public, at Burlington House, Piccadilly, W. 8 p.m. (1) Messrs. L. H. Lampitt, E. B. Hughes and H. S. Rooke, "Furfural and Diastase in Heated Honey." (2) Mr. J. W. Haigh Johnson, "Further Notes on Methods of Sewage and Water Analysis; Anti-Oxidation, and Stabilisation of Pollution." (3) Messrs. B. J. F. Dorrington, and A. M. Ward, "Potassium Cyanate as a Reagent for the Detection of Cobalt."

Thursday, April 4..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Major G. H. Scott, "Airship Mooring and Handling."

Linnean Society, Burlington House, W. 5 p.m.

Friday, April 5..Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Meeting of Meter and Instrument Section. Mr. E. W. Hill, "Some Technical Considerations Concerning Power Factor in relation to Tariffs."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. "Production of Graham-Paige Cars." (Technical Film).

Mechanical Engineers, Institution of, at the Chamber of Commerce, Birmingham. 7.30 p.m. Wing-Commdr. T. R. Cave-Browne-Cave, "Aircraft Engineering in its relation to Mechanical Engineering."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. D. R. Lamb, "Sidelights on the Transport Problem."

At Leeds. 7 p.m. Annual General Meeting.

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FRIDAY, APRIL 5th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

NEXT WEEK.

WEDNESDAY, APRIL 10th, at 8 p.m. (Ordinary Meeting.) G. H. NASH, C.B.E., M.I.E.E., European Chief Engineer, International Standard Electric Corporation, "Some Modern Aspects of Electrical Communication." SIR RICHARD A. S. PAGET, BT., will preside.

FRIDAY, APRIL 12th, at 4.30 p.m. (Indian Section.) A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India." SIR STANLEY REED, K.B.E., LL.D., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, FEBRUARY 8TH, 1929.

VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, and late Commander-in-Chief, East Indies Squadron, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said that Sir Edward Headlam spent a large part of his life in the Indian Marine, and during the last six years had been Director of that Service. He would not raise any blushes on Sir Edward's cheeks by referring to his services during the War, beyond saying that they had been very distinguished, and that the work he had done both during and since the War had been of great value and importance to India and the Empire. He desired to take the opportunity of acknowledging the great debt which he himself, during the time he had been Commander-in-Chief in the East Indies, owed to

Sir Edward Headlam for the manner in which he had assisted him in everything which had had to be done. Nothing could have been more admirable, and nothing could promise better, than the co-operation of the various services of the Empire at that time. Sir Edward Headlam had placed the Marine at the service of the Squadron on every possible occasion on which he had been asked to do so. It had been a most pleasant duty to work with him, and the pleasure which he had had in working with him in those days he was sure those present would have now in listening to what Sir Edward had to say.

The following Paper was then read :—

THE HISTORY OF THE ROYAL INDIAN MARINE.

By Captain Sir E. J. Headlam, C.S.I., C.M.G., D.S.O., R.I.M., Late Director, Royal Indian Marine.

At the commencement of this paper I should like to make it clear exactly what has been meant by the Indian Marine Service in the past. In England to the vast majority of people India is still but little known, and it is only natural that people should know still less about the smallest of all the Indian Government Services; in fact, it is no exaggeration to say that even in India itself a great many people do not know what were, and what now are, the functions of the Royal Indian Marine. There is also among those who do know something of the history of India a tendency to consider that the days when the Service was called the Indian Navy was its chief period of activity. It certainly was a glorious period of its history, as it included participation in wars in Burma, China, New Zealand, the Sepoy revolt in India and the Persian War. But the actual period during which the Service was called the Indian Navy was only 33 years.

By Indian Marine, for the purpose of this paper, I include the history of the Sea Service under whatever British form of Government obtained in India from the year 1612 until the present day, under the various titles it has been called at different periods.

The Sea Services under the Government of India have been known by varying titles since their first conception in 1617. Thus from 1612 to 1686 the Service was known as the Honourable East India Company's Marine, from 1686 to 1830 as the Bombay Marine, from 1830 to 1863 as the Indian Navy, and from 1863 to 1877 again as the Bombay Marine. In 1877 the title was altered to that of Her Majesty's Indian Marine, and this title lasted until 1892, when the present designation of Royal Indian Marine was finally adopted. The full title of the Service is His Majesty's Royal Indian Marine Service, but as this is rather ponderous for ordinary use it is called generally the Royal Indian Marine.

The opposition and annoyance caused to the East India Company by the Dutch, the Portuguese, and the pirates of the western coast, were the primary cause of the establishment of Naval Forces in India, of which the earliest

representative may be said to have been Captain Thomas Best, with his two ships, *Dragon* and *Hoseander*. These two vessels, together with others which arrived subsequently, reached Surat in 1612, and were engaged for three years in the almcst continuous warfare which culminated in the grant by the Emperor Jahangir to the East India Company of a firman, authorising the English to trade within his dominions. The Marine forces, which at this date (1615) consisted of ten armed grabs, or gallivats, formed the original nucleus of the Bombay Marine, and up to the year 1668 were engaged in a practically unintermittent and, on the whole, successful struggle with the Company's foes both along the Indian coast and in the Persian Gulf. In 1659, the year following the cession of Bombay by the Crown to the Company and the appointment to the Deputy-Governorship of Captain Young of the Marine, a further development took place in the construction at Bombay of small armed craft for the defence of merchant-vessels trading with the ports of the Persian Gulf and the Arabian Sea. Among other vessels, two small brigantines are recorded as having been built by Mr. Warwick Pett, who was a descendant of Sir Phineas Pett, the famous shipwright of Elizabeth's reign, and who had been despatched to Bombay for this purpose with a full supply of marine stores and equipment for ship-building.

The construction of these ships at Bombay, about 1670, may be regarded as the earliest step towards the withdrawal of the Marine from Surat to the island of Bombay, which lent the name by which it was distinguished up to 1829, and which to the present day serves as its headquarters. The Marine played a regrettably conspicuous part in Captain Richard Kegwin's infamous mutiny at Bombay in 1683; for the officers and crews of the *Revenge* and the *Hunter*, both being vessels of the Bombay Marine, threw in their lot with the rebels, Captain Alderton, of the *Hunter*, being one of the four ringleaders to whom a pardon was not granted under the Royal Commission of August 24, 1684. As a set-off, however, against these disloyal acts, it is to the credit of the Service that the final surrender of the island was obtained by Sir Thomas Grantham, an officer of the Company's Marine Forces.

Under the Royal Commission which dealt with this mutiny Sir John Child, the President of Surat, was appointed Captain General and Admiral of the Company's land and sea forces, with Sir Thomas Grantham as Vice-Admiral, and the senior Captain of the Company's ships as Rear-Admiral, the three thus becoming the earliest official heads of the Indian Marine Service. In the following year (1684) Sir John Wyborne was appointed Vice-Admiral and Deputy Governor of Bombay; and in 1686 the seat of the Company's Government was transferred from Surat to Bombay, the marine stores being located in the Castle, and the Company's ships being anchored in Bombay harbour.

The Marine suffered to some extent from the spirit of insubordination and dissatisfaction which characterised the closing years of the seventeenth century. In addition to the notorious wave of sickness which affiicted all classes at this

period, considerable reductions were made in the strength of the marine establishment, particularly during the administration of Sir John Child; and these two circumstances, in combination with other minor causes of dissatisfaction, gave rise to frequent desertion.

Matters, however, improved after the transfer of the seat of Government to Bombay; the marine forces became officially known as the Bombay Marine; an officer was regularly appointed Admiral every year; and the supply of men to both higher and lower ranks was maintained by drafts from Europe. These arrangements were indeed rendered absolutely essential by the need for protecting the island against the attacks of pirates, and by the fact that the Company had still to make headway against the superior maritime forces of the French, Dutch and Portuguese. Desertion too was still an evil to be reckoned with for several years to come, and culminated in 1724 in an order to hold the pay of all seamen two months in arrears, in the hope that this would act as a deterrent.

The first notable action fought by the Marine after its re-constitution was the siege of Gheria, the stronghold of Angria, in 1717. In the previous year the total strength of the sea forces consisted of one ship of 32 guns, 4 grabs mounting from 20 to 28 guns, and 20 grabs and gallivats carrying from 5 to 12 guns apiece, but in spite of this by no means inconsiderable armament, Angria's stronghold proved impregnable and Commodore Berlew had perforce to raise the siege. On the 5th November, 1718, the Marine laid siege to Kenery the force being under the command of Manual de Castro, whom the President, much to the annoyance of the English Captains of the gallivats, had appointed Admiral of the Fleet. It was no doubt partly on this account that the President had to engage volunteers for the attack, promising that the widows and children of any who lost their lives should receive respectively £30 and £10 apiece. The attack failed in spite of the bravery of Major Stanton and others, and it was in consequence of this ill-success that the President decided to add to the fleet " a floating-castle or a machine that should be almost cannon-proof." " This vessel," writes Downing, " was pretty flat, flowed with little or no bilge and but six-foot hold. The thickness of her sides was made by the nicest composition cannon-proof. She was to go with one mast and a top sail which was rigged in a very commodious manner, and mounted 12 guns carrying 48 pounders." This machine proved of very little service and was shortly afterwards destroyed as worthless. Four years later (1722) the Bombay Marine made a joint expedition with the Portuguese against Alibag, the latter providing the land force, the naval force consisting of three ships under Commodore Mathews.

A contemporary writer, alluding to the ill-success of the expedition, remarks that " the Viceroy of Goa with much pretended zeal came in person, designing to head such forces as he had raised, and the General of the North also came down to Bombay, and was most magnificently entertained by the President."

But on the day of the attack "the Viceroy of Goa went on board his ship, pretending that he was very ill. The Commodore sent his own doctor to offer his services and supply him with such medicines as should be convenient for him, if he was really ill. But the doctor returned and reported to the Commodore that he did not perceive anything to be the matter with him." The timidity, if not treachery, of the Portuguese Viceroy communicated itself to his troops and turned a well-timed attack into complete defeat, and the only satisfactory feature of the engagement was the behaviour of the Marine forces, which lost many officers and men.

During the early portion of the eighteenth century the position of Bombay, menaced as she was by the Portuguese, Sidis and Marathas, was so insecure that the Bombay Council spared no pains to enhance the value of the Marine both by improving the morale and numerical strength of the men and by increasing the fleet. Thus in 1731 the Court of Directors approved of a scheme of pensions for the widows of officers and seamen who had performed distinguished service; they indented largely upon their trading vessels for the manning of the warships; they purchased new vessels, notably the *Rose* galley in 1733, for Rs. 14,000; and in 1733 they brought down from Surat Lavji Nasarwanji Wadia, the Parsi ship-builder, who selected the present site for the Government dockyard. The Marine charges at that date amounted to Rs. 1,81,000 a year, and the fleet comprised, in addition to several gallivats and boats, seven large warships, namely the *Victoria* (frigate), the *Neptune* (grab), the *Prince of Wales*, the *King George*, the *Princess Caroline* and the *Rose* (all galleys), and the *Salamandar* (bomb ketch) Between 1739 and 1741 continual additions were made to the fleet under the auspices of Lavji Nasarwanji, as, for example, two 90-foot grabs, carrying 20 guns, and a 90-foot "sea-going ship" carrying 11 guns in a line, so that by the end of 1741 the Commodore was able, after inspection of the fleet, to report that the vessels were "entirely clear and in a proper posture for defence," and that the total strength of the fleet was :—One ship of 44 guns, 4 ships of 28 guns, 4 ships of 18 guns, 6 bomb ketches, and 20 large gallivats, manned altogether by 100 officers and from 1,700 to 2,000 seamen. Among the salient events of this period with which the Marine was directly connected may be mentioned the defeat of Sambhaji's fleet at the mouth of the Rajapur river by Commodore Bagwell and four cruisers on the 22nd December, 1738; the conclusion, by Captain Inchbird of the Marine, of a treaty with the Maratha General Chimnaji Appa on the 12th July, 1739; and the complete loss with all hands of three fine grabs, commanded by Captains Rigby, Sandiland and Nunn, in the terrible storm of the 9th November, 1739.

Discipline in these days was no easy matter. The ships were chiefly manned by British sailors, many of whom had been released from jails on their promising to serve, and a considerable number were deserters from British and other European vessels.

The year 1742 being void of " alarums and excursions," the Bombay Council decided somewhat prematurely to reduce their Marine establishment. They abolished the post of Admiral and contented themselves with a Superintendent, eight Commanders, one of whom was styled Commodore, three First and four Second-Lieutenants, four third officers and six masters of gallivats, together with a certain number of midshipmen. The immediate outcome of this action was that the mercantile fleet, now larger than ever, suffered serious losses at the hands of the pirates; while in 1744 after the declaration of war between England and France, when two French privateers were hovering off Bombay to intercept the East Indiamen, the only protective measures they could adopt were the equipment of three ships of inferior strength and the despatch of six fishing-boats to give the alarm to any English vessel approaching Indian shores.

Two notable events mark the close of the first half of the eighteenth century, namely, the mutiny on board the *Bombay*, in 1748, and the completion of the first dry dock (now the upper Bombay Dock), in 1750. The former event occurred while the *Bombay*, commanded by Captain Rough, lay at anchor off Rajapur. The mutineers attacked their officers while at supper, overcame them and placed them under an armed guard; but being wholly ignorant of navigation, and having nearly wrecked the vessel on a lee-shore, they were persuaded to return to duty on condition of receiving a free pardon, Rs. 200 in cash, and a free passage to England. These terms were carried out in all cases except those of Surgeon William Wills and four seamen. The former, convicted by a court-martial of exciting disaffection, was paraded through the fleet with a halter round his neck and hanged; and the latter had to submit to a severe public flogging. The dry dock previously mentioned was completed in 1750 and was the first dry dock in the East, and is still in regular use.

At the commencement of 1756 a Royal Naval Squadron, under Vice-Admiral Watson, visited Bombay for the first time since the island had become the property of the Company. Taking advantage of this circumstance, a combined military and naval expedition was despatched from Bombay against Vijayadrug, the stronghold of the pirate Tulaji Angria. The military forces consisted of 800 European soldiers, 300 Topasses, and 300 Sepoys under Colonel (afterwards Lord) Clive; while the naval forces comprised *H.M.S. Kent* (the flagship, 75 guns), *H.M.S. Cumberland* (flagship of Rear-Admiral Pocock, 66 guns), *H.M.S Tiger* (60 guns), *H.M.S. Salisbury* (50 guns), *H.M.S. Bridgewater* (20 guns), and *H.M.S. Kingfisher* (16 guns), and the Bombay Marine ships *Protector* (Commodore James, 44 guns), *Revenge* (28 guns), *Bombay* (28 guns), *Guardian* (28 guns), *Swallow* (16 guns), together with the bomb vessels *Drake, Viper, Triumph, Warora* and *Despatch.* On the latter were embarked a company of artillery under Captain Torey and the fleet was further augmented by grabs and 40 gallivats belonging to the Marathas. Suspicions, however, being entertained that the Marathas were acting in concert with Angria,

operations were precipitated so as to exclude them from all share in the enterprise. The Admiral having attacked and burned the pirates' fleet, Clive interposed his forces on the land side between the fort and the Maratha general who had hastened to co-operate. On February the 13th, 1756, the fort fell, and a large quantity of cannon, ammunition and specie fell into the hands of the victors. The total disappearance of Angria from the arena of external politics led to a proposal again to reduce the Marine, but this the Bombay Council declined to do, owing to the fact that war had broken out between France and England. Hence it came about that Commodore James was enabled, firstly, to seize the French ship *Indienne* and carry her as a prize into Bombay, and, secondly, to start on a voyage round the coast of India in the middle of the south-west monsoon, with the object of proving that communication between the eastern and western coasts of India was possible at all seasons of the year. This feat of navigation, which largely revolutionised the existing ideas of the value of the Marine, was of double service to the English, for Commodore James not only brought to Bengal the first tidings of the outbreak of hostilities with the French, but also lent 500 men from his ships to Fort William, by which timely accession to their strength Admiral Watson and Colonel Clive were enabled in March, 1757, to capture Chandernagore, and thus deal a severe blow to French power and commerce in the East.

Commodore James retired shortly after this and was presented with a sword of Honour by the Directors and a seat on the Board, of which he afterwards became Deputy Chairman and also entered Parliament. In 1778 he was created a Baronet and subsequently became Governor of Chelsea Hospital and an Elder brother and Deputy Chairman of Trinity House.

During the critical years of warfare between France and England the ships of the Bombay Marine were constantly engaged in co-operating with the Royal Navy, fighting actions off the Indian coasts, and in successfully acting as "the police of the Indian seas" against the many bands of pirates which still infested the Persian Gulf and western coast. Their excellent services had the effect of directing the Company's attention more closely to their circumstances and welfare; and the stringent orders from the Court of Directors anent the religious and moral character of both officers and men, and the prohibition in 1751 of gambling and swearing, were followed in 1760 by permission to wear a regular uniform, and in 1766 by the issue of a complete set of orders regarding discipline for the use of Commanders, which constituted the first body of official regulations ever published for the Marine service. Later, in 1771, the pay of seamen, who had been in the habit of demanding exorbitant wages, was formally regulated, and the total force, which had somewhat outgrown the needs of the period, was reduced and re-organised. The year 1772 witnessed the first surveying expedition undertaken by the Bombay Marine. It consisted of the schooner *Fox* (6 guns), the *Dolphin* ketch, and one patamar under the command of Lieutenant Robinson, aided by Lieutenant Porter and Midshipmen

Blair and Miscal, who engaged to explore the coast of Mekran, Sind, and Kathiawar, and a portion of Arabia and Persia. They may be said to have laid the foundations of the present Marine Survey of India, which throughout the various vicissitudes of the Indian Naval Service has ever continued to carry out the arduous task of scientifically delineating the coasts of India, Burma, and the Persian Gulf. Two years later (1774) a squadron of the Bombay marine under Commodore Watson co-operated with Brigadier-General Robert Gordon in the attack and capture of Thana from the Marathas, and in 1755 occurred an heroic struggle between the *Ranger*, commanded by Lieutenant Pruen, and an overwhelming Maratha fleet under the command of the Peshwa's Admiral Anandrao Dhulap, in which nearly every officer and seaman on board the *Ranger* was either dangerously wounded or killed.

In 1780 the ships of the Bombay Marine formed part of the squadron under Sir Edward Hughes which co-operated in the suppression of Hyder Ali ; and in December two years later (1782) a squadron under Commodore Armitage, who flew his broad pennant in the *Bombay*, acted in concert with General Mathews on the Malabar coast and helped to capture Rajamandrug, Meju, Kundapur, Annanpur and Mangalore. In brief, there was hardly a naval engagement in the East during the latter half of the 18th century in which the Bombay Marine did not play a part ; and it rendered excellent service at the capture of Pondicherry, Trincomalee, Jafnapatam and Colombo. Among minor engagements may be mentioned that between the *Vigilant* (6 guns) commanded by Lieutenant Hayes and four vessels belonging to the Sanganin pirates in 1797. The *Vigilant* had been despatched on a political mission to the Hakim of Soumiana, and while crossing the Gulf of Cutch was attacked by the four pirate ships, each of whom was more than double her size. After three hours desperate fighting, during which she had two of the enemy's vessels lashed on each side, the *Vigilant* managed to drive them off with complete loss. During this period of almost continuous warfare, the casualties, such as that of the *Revenge* which foundered with all hands in 1782, were largely counterbalanced by the zeal in shipbuilding of Maneckji Lavji, one of the famous family which for more than a century held the post of master ship-builders to the Marine.

The year 1780, and those immediately following it, were particularly notable for activity in ship-building, among the finest vessels launched from the Government dockyard being the *Malabar* (74 guns), and the *Ganges* (92 guns), which afrerwards served as the Flagship of Sir Edward Codrington at the battle of Navarino.

It had been found that the teak forests of Malabar produced timber which was not only more durable than oak, but also contained properties which rendered it less susceptible to the *teredo* worm so prevalent in Eastern waters. Moreover oak was becoming scarce in England, and the cost of labour in India was so low that a battleship could be built in India for £20,000 less than in England.

The first sea-going ship built by the Wadia family in the Indian Marine Dockyard in Bombay was launched in 1735. The last was the surveying ship *Investigator,* built in 1881, which was in commission for nearly thirty years. Many famous ships were built for the navy as well as the two previously mentioned, among them the *Euphrates, India, Hindostan,* and *Asia.*

In August, 1798, the Court of Directors revised the Marine Regulations, conferred relative rank as well as a retiring pension upon the officers, and formally prohibited the privilege of private trading which had up to that date been permitted to all members of the Marine service. Further, the duties of the service were distinctly defined to be :—(*a*) The protection of trade ; (*b*) the suppression of piracy and the performance of the general duties of war vessels ; (*c*) the convoy of transports, and, if necessary, the conveyance of troops ; (*d*) the prosecution of Marine Surveys in the East. A civilian Superintendent, Mr. Philip Dundas, was appointed head of the Marine Board, and the two senior officers in the service were respectively appointed Master-Attendant and Commodore at Bombay. The remainder of the personnel comprised 13 Captains, 33 First-Lieutenants and 21 Second-Lieutenants, and 37 Volunteers. Later, on the 31st May, 1814, a table of procedure in India was fixed by the warrant of the Prince Regent, whereby the Superintendent of Marine took rank after Generals and Flag-Officers, Commodores after Commodores of the Royal Navy, and Senior Captains after Captains of the Royal Navy of more than three years' service. Fresh regulations as to uniform were published in 1820, and in 1824 the rank of Commander was temporarily abolished and an increased number of Captains' appointments were created. Finally, on the 30th June, 1827, a Royal Warrant conferred upon the officers of the Indian Marine equal rank, according to their degree, with officers of the Royal Navy within the limit of the East India Company's Charter, a warrant from the Admiralty permitted the vessels of the Bombay Marine to fly the Union Jack and Pennant, and it was decided that an officer of the Royal Navy should henceforth be Superintendent or head of the Marine Service. The year 1830, the last of the period under discussion, witnessed the inauguration of a family pension fund under the auspices of the Bombay Government, and the alteration of the title of the service to that of Indian Navy, the number of officers at this date being 12 Captains, 9 Commanders, 51 Lieutenants and 69 Midshipmen.

Captain Sir Charles Malcolm, C.B., was the first officer of the Royal Navy to be head of the Marine. He was also the founder of the Bombay Geographical Society, now no longer in existence, and the first important act of his administration was the commencement of the Red Sea survey.

Meanwhile the service had successfully maintained its reputation for efficiency and courage. Several vessels of the Bombay Marine participated in the Egyptian Campaign of 1801, under Sir Ralph Abercrombie, and in 1803 a squadron under Commodore John Hayes was despatched to protect the trade

of the Bay of Bengal from French aggression. It was during this year that the Company's fourteen-gun brig *Fly*, carrying despatches, was captured in the Persian Gulf by the French frigate *La Fortune*, commanded by the famous Captain Surcouff. The commander of the *Fly* with great gallantry succeeded in running his ship into shoal-water and there sinking all his treasure and despatches in order to prevent their being seized by the enemy.

In 1810 a squadron of five Bombay ships under Captain Deane helped the naval forces under Admiral Bertie to take Mauritius and capture the French ships in Port Louis. In 1811 another squadron under Commodore Hayes participated in the conquest of Java. For their services on this occasion the officers and men received the medal granted for the expedition and were warmly thanked by the Governor-General, Lord Minto. Again, in 1813, the Bombay Marine was employed in the action against the Sultan of Sambar, losing many men from wounds and sickness; and in 1815 a small squadron under Captain Blast was despatched to blockade the coast of Cutch and the strongholds of the piratical tribes of Kathiawar. During the Maratha war war the attack on the fort of Suvarandrug, in December, 1817, and the reduction of the fort of Madangad, gave further opportunities to the Bombay Marine to display its fighting capabilities, which were warmly acknowledged by the Governor-General in Council and by Colonel Kennedy, who commanded the assault on the latter stronghold. In 1819 a squadron under Captain Hall performed yeoman service in the extermination of piracy in the Persian Gulf. The year 1820 was memorable in marine annals for the siege of Mocha, which fell after a spirited defence on the 27th December, chiefly owing to the gallant conduct of the Bombay Marine forces under Lieutenants Faithful, Robinson, Jones, Elwin, and Tanner; and in the following year Captain Hardy (*Teignmouth*), Commander Start (*Prince of Wales*), Lieutenant Dominicitti (*Psyche*), and Lieutenant Robinson (*Vestal*) fought the famous action which reduced the Ben-ibn-Ali Arabs to submission. On the close of the 1st Burmese war, in 1826, the Bombay Marine shared with the Royal Navy the thanks of both Houses of Parliament for their "skill, gallant, and meritorious exertions" in the operations against Ava; while in 1827 the *Amherst* was employed under Sir Gordon Bremner in blockading Berbera and the adjacent Somali coast as a reprisal for the plunder of an English brig by Somalis in 1825.

Nor was the important work of Marine surveying neglected during these early years of the nineteenth century. A Marine Survey Department was established in Bengal in 1809, Captain Wales of the Bombay Marine being appointed the first Surveyor-General, and much important work was carried out in the Bay of Bengal by the *Assaye*, the *Panther*, and the *Antelope*. In the year previous Captain Horsburg, Hydrographer to the Company, published the first edition of his East India Directory, which was largely based upon the surveys carried out by officers of the Bombay Marine. In 1811 the *Ternate* and the *Sylph* under Captain Suree surveyed the East Coast of Africa as far

South as Zanzibar, and from 1821 onwards, under the auspices of Captain Daniel Ross, a thorough survey of the Persian Gulf and other seas was performed by Lieutenants Wellstead, McCluer, and Haines. In the schemes for retrenchment which Lord William Bentick formulated in 1828 the Marine Survey Department was almost abolished, but so important was its work acknowledged to be that in 1830 two brigs were again commissioned for survey duties. In the same year Commander John Nilson undertook an experimental voyage in the *Hugh Lindsay*, a steamer built in Bombay, with the object of proving that the Red Sea route must, with the advent of steam, become the high-road between Europe and India. The voyage to Suez took 29 days, and in spite of the difficulty of carrying sufficient coal in so small a vessel (411 tons) it was successful.

Some idea of the hardships these early surveyors underwent may be realised when we consider that in the burning heat of the Red Sea, the East Coast of Africa and the Persian Gulf they were away from civilisation for two and three years at a time in small ships of two or three hundred tons, dependent on local and nearly always brackish water, and largely living on bad biscuits and salt pork and beef in confined spaces, where it was impossible below decks for an average man to stand upright.

The Bombay Marine and Indian Navy saw a considerable amount of service in the nineteenth century. On the 16th April, 1835, Captain Sawyer, of the *Elphinstone*, shattered the power of the Beni-yas Arabs of the Persian Gulf, who had fitted out a powerful fleet of three hundred bagalas with the avowed intention of attacking and overpowering the Company's cruisers; and in the same year several officers of the Indian Navy took part in the successful expedition which explored the Shat-el-Arab and Euphrates, and paved the way for trade by peaceful negotiations with the Arabs. Three years later (1838), when it was decided to occupy Afghanistan, the vessels of the Indian Navy were employed to convey troops to the mouth of the Indus and to act as a blockading squadron at that point; while in 1839 a squadron was despatched to aid in the occupation of Karachi, which, however, fell without a struggle. In the same year, during the operation which followed the evacuation of the British Residency at Bushire, the Indian Navy ships *Tigris* and *Euphrates* were placed under the orders of Admiral Maitland, who, on relinquishing his command in the Persian Gulf, passed a high eulogy upon the conduct of both officers and men; and a still more favourable commendation was passed both by the Court of Directors in 1840 and the Bombay Government in 1839 on the conduct of Commander Haines, Lieutenant Daniel and Midshipman Nisbett at the bombardment and capture of Aden in the latter year. Nor must mention be omitted of Captain Moresby and Lieutenant Barker, both officers of the Indian Navy, who concluded the commercial treaty of 1840 with Sultan Muhammad of Seila, whereby the Mussah Islands in the Bay of Tajura were ceded to the British. The same year is memorable for the outbreak of the

China war (1840-42), when the Indian Navy ships *Auckland, Sesostris, Akbar, Memnon, Medusa* and *Ariadne* co-operated with the Royal Navy; while in 1843 the *Mootner*, the *Satellite* and the *Planet*, under Commander Nott, participated in the expedition to Sind, the officers and crews of the three ships taking part in the battle of Miani and the capture of Hyderabad, and receiving the Sind Medal with clasp for their services. Shortly afterwards, on the outbreak of the insurrection of 1844-45 in the Southern Maratha Country, the Indian Navy carried to Vengurla the troops despatched to quell the revolt; and in the military operations of 1845-46 in New Zealand the *Elphinstone* under Commander Young played a prominent part in the capture of Ruapetapekar. Well deserved, too, was the commendation passed by the Court of Directors and the Governor-General upon Commander Powell and his men who constituted the Indus Flotilla during the operations prior and subsequent to the Siege of Multan in 1848-49; and the honours awarded to officers of the Indian Navy on the close of the Second Burma war (1852) were universally held to be but a just acknowledgment of the services of men who had shared in the capture of Martaban, Rangoon, Bassein, Prome and Pegu, and had borne no small part in the suppression of dacoity on the Upper Irrawaddy. One of the salient features of the war was the excellent shooting of the Indian Navy Flotilla, which contrived, as stated by a contemporary writer, that the shell burst to a hair's breadth just where they were intended to, and did the precise amount of mischief required. The year 1852 also witnessed the suppression of pirates on the north-east coast of Borneo by the *Semiramis* and *Pluto*, while the *Queen* and the *Elphinstone* were engaged four years later (1856) in helping the Turks to defend Hodeida.

Meanwhile the condition of affairs in Persia was such as to oblige the Indian Naval authorities to strengthen their squadron and commission new warships. The fall of Herat brought matters to a head, and on the 1st of November, 1855, the Governor-General issued a declaration of war against Persia. The naval portion of the forces engaged was drawn entirely from the Indian Navy, with Rear-Admiral Sir H. J. Leeke in command, and Commodore Ethersay of the Indian Navy as second-in-command. Bushire was bombarded and captured on the 10th December, 1856, and a similar fate befell the strongly fortified town of Mohammerah on the 26th March, 1857. The latter action drew from the Governor-General in Council a most eulogistic notification, of which the following is an extract:—"That the officers, seamen, artillerymen, marines and others of the squadron did their duty with intrepidity and ardour is the smallest part of the praise which is owing to them. The plan of the naval attack, which was to be carried out in shoal and narrow waters, and in a rapid current, by steamers of heavy draught, some of them encumbered with vessels in tow, and the thoroughly successful execution of every part of it, without miscarriage or confusion of any kind in face of strong defensive works at point-blank range, have given proof of a cool judgment, a well-ordered discipline,

and a skilful management, of which Commodore Young and the officers and men under his command may well be proud." Among minor services performed by the Indian Navy at this date may be mentioned the participation of the *Auckland* (Commander Draught) in the suppression of piracy in Borneo in 1856-57, and in the military operations in South China, as well as the seizure of Perim Island in 1857 by Lieutenant Templar, commanding the *Mahi*.

The outbreak of the Indian Mutiny in 1857 offered the Indian Navy further opportunity for active service. A naval brigade from the *Auckland*, *Punjab*, *Semiramis*, *Zenobia* and *Coromandel* served for nearly three years in the military operations in Bengal and Assam; the *Berenice* and *Victoria* transported troops both to Karachi and the ports of the South Konkan in the teeth of the south-west monsoon; a second naval brigade co-operated wlth the military forces in the Southern Maratha country; and Captain Jones of the Indian Navy earned the unqualified approval of both the Indian and British Governments for his energy and success in holding Persia and the Arab tribes of the Gulf at bay during the greatest crisis that British prestige in the East has ever had to face. The tale of the war services of this period closes with the successful bombardment of the Island of Bet, in the Gulf of Cutch, in 1859, and the prosecution of the China war of 1860, in the course of which the attack on the Taku forts was led by the *Coromandel*, under rhe command of Lieutenant Walker of the Indian Navy.

I may mention that two V.C's were won by the Indian Navy in the Mutiny.

As regards the organisation of the Marine and Indian Navy from 1830 to 1863, various facts deserve notice. In the first place, the appointment of Master Attendant was abolished about 1831, his place being taken by a Controller of the Dockyard; and in 1838-39 a steam packet service for the carriage of mails to Egypt was instituted as an integral branch of the Service. In fact, from this date the Service commenced to exchange its sailing vessels for steamers; the whole nature of the service was altered, and the establishment was reduced from 7 Captains, 12 Commanders and 45 Lieutenants to 4 Captains, 8 Commanders and 40 Lieutenants. This reduction resulted in many of the ships being under-officered, so that in 1841 the establishment had again to be increased to 6 Captains, 12 Commanders, 48 Lieutenants and 72 Midshipmen and mates. Nor was this increase final, for in 1847 orders were issued fixing the complement of officers at 8 Captains, 16 Commanders, 68 Lieutenants, 110 Midshipmen, together with 14 Pursers and 12 Captain's clerks, 14 Masters and 21 Second Masters.

At the same time the Superintendent was created a Commodore of the first class in the Indian Navy, while the Assistant Superintendent was always to be a Captain on the effective list. The post of Superintendent was, however, finally abolished in the year following (1848), Commodore Sir Robert Oliver being created Commander-in-Chief of the Indian Navy; and the broad pennant of the Indian Navy, which had up to that date been identical with that of

the Royal Navy, was exchanged for a red flag with a yellow cross, and the Company's cognizance of a yellow lion and crown in the upper canton nearest the mast.

Despite the almost continuous war service on which the Bombay Marine and the Bombay Navy were employed in the first sixty years of the nineteenth century the important work of hydrographic surveying was not neglected. In spite of difficulties and privations surveys were carried out on the East Coast of Africa, the Gulf of Aden, the Persian Gulf, the Maldive and Laccadive Islands and on the Coast of India and Burma. In 1861 the Indian Hydrographic Office was abolished and the Survey Department worked in close co-operation with the Hydrographer of the Admiralty, by whom all charts were published, and this procedure continues to the present day.

On the abolition of the title of Indian Navy officers were given the opportunity of retiring on pension or of accepting the new conditions; the European ratings were gradually paid off and entire Indian crews substituted, these being recruited from the Mohammadan seafaring people of the Ratnagiri district south of Bombay, the descendants of the old Maratha pirates against whom the old Bombay Marine had so long struggled. These men have formed the crews of R.I.M. ships until this year, when recruiting has been opened all over India. The title of the Service now again became the Bombay Marine. Practically immediately that the Indian Navy was abolished it was generally conceded both at home and in India that the policy was a mistaken one. However, it was too late to alter it, and as is well known, Governments are not prone to acknowledge they have been in the wrong. A scheme was discussed to maintain an armed squadron in the Persian Gulf, but except that certain of the ships still carried their guns, nothing very much came of it. The ships continued to carry on naval duties in a reduced manner and in 1867 the Indian Troop Service was organised.

This was followed in 1877 by the entire reorganisation of the Marine Service, Captain (afterwards Admiral) Bythesea, V.C., C.B., C.I.E., having been appointed Consulting Naval Officer to the Government of India for this purpose in 1874. In accordance with the scheme propounded by Captain Bythesea, the Bombay Marine was amalgamated with the other Marine establishment in India under the title of Her Majesty's Indian Marine, the service being divided into a western division with its headquarters at Bombay, and an eastern division with its headquarters at Calcutta; and the duties of the amalgamated service were defined to be (*a*) the transport of troops and government stores on the Indian coasts or to any country to which it might be necessary to despatch troops; (*b*) the maintenance of station-ships in Burma, the Andaman Islands, Aden, and the Persian Gulf, for political, police, lighting and other purposes; (*c*) the maintenance of gunboats on the Irrawaddi and Euphrates, and (*d*) the building, manning, repairing and general supervision of all local government vessels and launches and of vessels and launches used for military purposes.

In 1882 the rapid extension of the Marine Service led to the abolition of the appointments of Superintendents at Bombay and Calcutta, which had formed part of the reorganisation scheme of 1877, and to the creation in their place of a Director, who was always to be an officer of the Royal Navy, with his headquarters in Bombay, and of a Deputy Director, to be an officer of the Indian Marine stationed in Calcutta. In October, 1887, the present Indian Marine Act came into force, and in 1891 Her Majesty Queen Victoria issued an order in Council altering the title of the Service to that of Her Majesty's Royal Indian Marine Service, usually called the Royal Indian Marine, and providing that the officers of the Marine should rank with, but junior to, Royal Naval Officers of equal rank, and should wear the same uniform as officers of the Royal Navy, with the exception of the device on the epaulettes, sword-hilt, badges and buttons, and of the lace on the sleeves. Previously, in 1884, the Admiralty had issued a warrant sanctioning the use by ships of the Royal Indian Marine of a special ensign (a blue flag with the Star of India in the fly) and the Marine Jack (a Union Jack with narrow blue border).

New regulations, designed to ameliorate the position of petty officers and seamen in regard to pension, were published in 1906, whereby the men were enrolled in the first instance for three years, with the option of electing for further service.

Hydrographic Surveying continued to be an important branch of the service, and in 1884 a naturalist was appointed to the *Investigator*, and since then an enormous amount of scientific research has been carried out by a succession of naturalists.

In 1871 the Indian Naval Defence Squadron was formed; this consisted of the two turret ships *Abyssinia* and *Magdala*, which were commanded and manned by the Marine, the guns being manned by the Royal Artillery.

In 1892 this squadron was increased by the addition of two torpedo gunboats and 7 torpedo boats and the Squadron was handed over to the Admiralty for the defence of India. The Squadron was commanded by a Captain of the Royal Navy as Senior Naval Officer, and was officered and manned partly from the navy and partly from the R.I.M. It was in this Squadron that the R.I.M. personnel received their war training, enhanced in the cases of officers by courses at Portsmouth and Greenwich while on furlough. The Naval Defence Squadron, which had become obsolete, was abolished in 1903.

Notwithstanding that after the abolition of the title "Indian Navy" the Marine was officially considered to be a non-combatant service, it still took its part in the struggles of the Empire.

Ships of the Bombay Marine and hired transports under the command of the Superintendent conveyed the expeditionary force from India on the outbreak of the Abyssinian war in 1868; while two of the service gunboats, the *Clyde* and the *Hugh Rose*, took part in the operations against Bahrein in 1870. The troops, guns and ammunition required for the prosecution of the Afghan

campaign of 1879 were likewise conveyed to Karachi by Indian Marine vessels, as also were the troops engaged in the Egyptian campaigns of 1882 and 1885. The year 1885 witnessed the fitting out of the R.I.M. turret-ship *Abyssinia* on a war-footing in consequence of the strained relations between the British and Russian Governments; and in October of that year the troopships and river steamers of the Indian Marine were again busily employed in the third Burmese War. This was followed by the Chin-Lushai expedition of 1889 and the Suakim expedition of 1896, in which the Indian Marine played an equally useful role; while on the outbreak of the South African War in 1899 the entire contingent from India was despatched by the Director of the Royal Indian Marine from Bombay with unequalled celerity, and a considerable number of the officers and seamen of the service were employed in transport and allied duties. The Service received the thanks of both Houses of Parliament for the celerity with which the troops from India were despatched to Natal.

The Indian Marine again saw service in North China in the Boxer rebellion in 1900-01, and in Somaliland in 1902-04, and in the gun-running operations in the Persian Gulf in 1911-12.

The outbreak of the Great War naturally found the R.I.M. unfitted to take a part as a naval service in the defence of the Empire, the officers being only partly trained for war, and the men, though loyal and well disciplined, untrained in combatant duties.

The troopships *Dufferin, Hardinge* and *Northbrook*, built to carry guns in war time, were immediately armed, as were also the smaller ships *Lawrence, Dalhousie* and *Minto*. These were handed over to the Navy and placed under a Naval Commander with R.I.M. officers and crew, the crews being strengthened with naval ratings.

All these ships were actively employed, the *Northbrook* being at one time the Flagship of the East India Squadron. The *Hardinge* took an active part in the battle of Toushoum, in the Suez Canal, where she suffered fairly heavily.

The *Dalhousie* flew the Broad Pennant of the Senior Naval Officer in the Persian Gulf, and the ships were chiefly employed in the Indian Ocean, Persian Gulf and Red Sea patrols. Of the remaining officers many were transferred to the Royal Navy, serving in H.M. ships or as Naval Transport Officerrs and Officers of the Inland Water Transport, in which department many of them were transferred to the Army. The men were employed in R.I.M. ships or in the R.I.M. ships which had been transferred to the Navy and Naval Transport staffs, and with the I.W.T. in Mesopotamia.

It is interesting to note that though there were less than 200 officers in the R.I.M. there were at one time or another officers of the R.I.M. serving in the Grand Fleet, the North Sea, Atlantic, France, Mediterranean, Egypt, the Red Sea, Mesopotamia and East Africa.

The retired officers volunteered for service to a man, and those who were not too old to serve served as Naval Transport Officers and officers of the I.W.T.

in France. In fact, the organiser and head of the I.W.T. in France until his death was Brig.-General G. Holland, C.B., C.I.E., D.S.O., a retired Commander of the R.I.M.

The officers of the R.I.M. gained 65 British and 6 foreign honours for service during the war, and many of the men received the India Distinguished Service and Meritorious Service Medals.

After the War the Government of India asked Admiral of the Fleet Lord Jellicoe, who was visiting India, to draw up a scheme for the reorganisation of the Service. His valuable suggestions were unfortunately too ambitious for Indian finances and could not be accepted.

Shortly afterwards the Esher Committee arrived in India to report on the Indian Army, and although the R.I.M. was not included in their terms of reference, they strongly recommended that the R.I.M. should be reorganised as a combatant service. The Government of India in 1920 obtained from the Admiralty the services of Rear-Admiral Mawby as Director, R.I.M., to draw up a scheme of reorganisation within limited lines. His scheme, however, was not adopted, and Admiral Mawby resigned his appointment.

The R.I.M. then fell upon hard times; money was scarce, the report of the Inchcape Committee necessitated drastic retrenchments, and the working of the Montagu-Chelmsford reforms resulted in the Local Governments having to defray the cost of the work of R.I.M. ships on their various stations, on lighthouse duties, transport work, carrying of officials, etc. The Local Governments were naturally inclined to think that if they had to pay they would like to have a say in the management, and that if the work could be done cheaper locally, they should arrange to carry out the duties themselves. Further, the Inchcape Committee recommended that the three large troopships should be scrapped and all trooping carried out under contract, which would have left the Marine with only the Survey Department and the Bombay Dockyard.

Happily for the Service, however, the Government of India in 1925 appointed a Departmental Committee under the Chairmanship of General Lord Rawlinson, in his capacity of Minister of Defence and Member of Council in charge of the Marine Portfolio, to submit a scheme for the reorganisation of the Service as a combatant force.

This Committee recommended that the Service should be reorganised as a purely combatant Naval Service with the title of Royal Indian Navy, with a strength in the first instance of 4 armed sloops, 2 patrol vessels, 4 mine-sweeping trawlers, 2 surveying ships and a depot ship, the Service in the first instance to be commanded by a Rear-Admiral on the active list in the Royal Navy.

The scheme was accepted by the Indian and Home Governments, and the necessary Act to permit India to maintain a Navy was passed through both Houses of Parliament.

To effect the change in the title it was necessary to draw up a new Indian Naval Discipline Act, and this had to be passed in the Legislative Assembly and Council of State in India. The Bill was introduced in February, 1928, when the Government were defeated by one vote, the defeat being caused, not by the fact that the people of India did not want an Indian Navy, but because in some cases members did not consider that the Legislature had been properly and fully consulted beforehand. Other members voted against the Bill on principle, as they considered that both Army and Navy should be directly controlled by the Legislature, while the extremists voted against it because they were prepared to vote against any Government Bill which might be introduced.

The blow to the Service was a heavy one, as it was feared that the defeat might put an end to the reorganisation. The Government, however, decided that the reorganisation should continue on the original lines, except that the title could not be altered, and that the service would have to use the old Discipline Act, a perfectly correct "Articles of War" based on the Naval Discipline Acts. To this organisation I have never heard any Indian, politician or otherwise, advance any objection, and all of my Indian friends are pleased and proud of the change, which among other things includes the admission of Indians to commissioned rank in the proportion of one to three.

In the present year, on the recommendation of the Admiralty, His Majesty the King has been pleased to approve of the change in uniform of officers to that of the Royal Navy, with the exception of the buttons of the R.I.M., which bear the Star of India as a distinctive mark, and also of the flying in R.I.M. ships of the White Pennant and the White Ensign of the Royal Navy, the greatest honour which can be conferred upon any sea service. The White Ensign was hoisted for the first time on Armistice Day, November 11th, 1928.

The Indian Marine is now reorganised as one of the fighting forces of the Empire under the command of a Rear-Admiral on the active list of the Royal Navy. Its duties are purely naval and its personnel are trained for war, and I would like here to quote from the report of a captain in the Royal Navy on board whose ship the R.I.M. ratings attached to the Shanghai Defence Force were permitted to continue their training. He wrote: "Their naturally smart and alert bearing was a distinct asset in field training and gun drill, and not the least benefit of the course was the example set by the R.I.M. ratings in keenness and zeal to all those who saw them at work. The relations between the instructors and the class were excellent from the first, and were soon supported by strong mutual respect. It is clear that the R.I.M. personnel represent most skilled fighting material."

It is probable that in the future the R.I.M. will be chiefly employed for the defence of the Indian seas, coasts and harbours, and I think that we may rest assured that the Service will worthily uphold the great traditions of its past history and maintain an honourable position among the Navies of this great Empire.

DISCUSSION.

Major General Sir Percy Cox, G.C.M.G., G.C.I.E., K.S.C.I., remarked that he was delighted to be present at any gathering which brought together the members of the old Service which he knew so well. He had the very happiest memories of his association with the Indian Marine, and he could only think of them with the deepest obligation and affection. Altogether, including the War, he had been associated with the Service for thirty years. Most of those present knew the recent history of the Indian Marine and did not need him to tell it, but he would like to go back to the many inherited memories which he had from the gallant old officers of the Service whose names were still to be conjured with, and which were still to be seen on the Admiralty charts. The Indian Marine not only served on the sea, but also, in their association with the Political Service, had come to know so much about land politics that several of them had been drafted into the Political Service—for instance, Commander Felix Jones, who had been for many years Resident at Baghdad, and Lieutenant Bruce, who had been Resident at Bushire. Personally, he could remember, as Resident of Bushire, having a store-room full of very old records of the Service from the times of the East India Company, and some of those records had afforded him very delightful reading. In the days of Lieutenant Bruce, His Majesty's Minister at Teheran, who depended on Bushire for his mails and communications with India, had written to Lieutenant Bruce saying that he was expecting some guests, and that his cellar had run low and that he would be most grateful if Bruce could help him out. That was in the days when it took about a month's travel from Bushire to Teheran. Lieutenant Bruce had written back most apologetically, saying that unfortunately the occasion found his own cellar also very low, and that the best he could do was to send 130 dozen of beer. Another old record which he could remember took the form of a long correspondence which had taken place in the time when the *Hugh Lindsay* had been on duty in Bushire, and which had had to do with a feud between the officers of the *Hugh Lindsay* and the officers of the Residency for the favours of an Italian theatrical company who had been at Bushire for a few days. Perhaps, also, some of those present would remember the story of Mr. and Mrs. Bagstock, which, unfortunately, would not bear repeating at that meeting! He had been most interested in the lecture, and it had been a very great pleasure to him to be present.

Admiral Sir Drury St. A. Wake, K.C.I.E., C.B., said his experience of the Indian Marine had been mostly during the War when he had been in charge of the Persian Gulf from 1915 to 1918, when several ships of the Indian Marine had been attached to his Flag, the officers doing the same duty in every way as his own officers. In that connection it had been rather hard lines on the officers of the Indian Marine, and he had written home and had told the Admiralty so. They had done the same work and had to stay out a considerably longer time than his own officers, but drew only half the pay. One rule which he had had to make out there for his own officers and men was that they were sent home after two years, as otherwise they died or had to be invalided out of the Service. The Admiralty had agreed with him in that, and had relieved his men every two years. But he had had Indian Marine officers under him who had been out there for five years, or even more. That was very bad for them in many ways, both morally and physically, and he was thankful to say that the Admiralty had altered that state of things. He hoped he had been the means, by the correspondence that he had had with the Admiralty, of improving the position of those officers very considerably, who, while they had been under him, had served him very loyally and well, and whose knowledge

of the Station had been of the greatest possible help to him. He had recommended several of them for gunnery ratings in the Grand Fleet, and he believed they had succeeded in getting them. They had learned gunnery under him to a great extent, and had taken the keenest interest in it. They were just as good as his own officers, and he had been extremely sorry to say goodbye to them. If any of those present desired to get a very good knowledge of the sort of work which the Royal Indian Marine had had to contend with in the Persian Gulf he would advise them to read Sir Arnold Wilson's book on the subject, which gave a truly marvellous account of the Persian Gulf and the operations which had taken place there, not only in modern but in ancient times. Personally, he had the very greatest respect for the Royal Indian Marine.

Lieut.-Col. Sir Arnold T. Wilson, K.C.I.E., C.M.G., C.S.I., D.S.O., said he knew he could say on behalf of the members of the junior ranks in the Royal Indian Marine that they more than reciprocated the kindly feelings which Admiral Sir Drury Wake had expressed. He had heard a great deal on the subject from Sir Drury, and he was perfectly certain that if Admiral Wake's despatches to the Admiralty had been as vivid as his conversations with his friends on that and allied subjects, they must certainly have carried conviction!

Perhaps he might be pardoned for saying that he regretted the absence from the lecture of any mention of the famous names of Constable and Stife—names he had been accustomed to see on every chart as a sort of proof that it was a good chart. Nor had the lecturer quite done justice, he thought, to the extraordinary variety of work which had been done in earlier years by different members of the Indian Marine. Captain Moresby had given his name to the present Capital of New Guinea. Welstead had written a book on the archæology of Southern Arabia which had not yet been replaced, and Assistant Surgeon Carter had written a monograph on the geology of Southern Arabia which had only been replaced by a more detailed study during the last twelve months. The lecturer had mentioned natural history as being a subject which had been undertaken pretty thoroughly by the naturalists attached to the Service, some of whose monographs were very valuable indeed. He himself had compiled a bibliography of some sixty items concerning the Persian Gulf alone in the region of natural history which were owed primarily to the Royal Indian Marine Natural History Service. With regard to the War in Mesopotamia, the Royal Indian Marine had been first in the field, and for nearly eighteen months had been responsible for the Marine transport and river transport under enormous difficulties. He need not enter into a *post mortem* of the difficulties met with in Mesopotamia in those days, but he would like to point out one thing of which the lecturer might possibly be unaware. The number of Indian Marine officers who were on duty in Mesopotamia had been about 30 at the end of 1915. The new water transport had then been introduced from the War Office, and the numbers had gone up to approximately 800 officers and 10,000 or 12,000 other ranks. At the Armistice he had made enquiries as to what had happened to the original 30 officers of the Royal Indian Marine, and he found that of the 30, 20 were still holding either their original positions or more important ones, and that nearly half the posts of importance in the I.W.T. in Mesopotamia were held by the officers of the Indian Marine. That was perhaps the best possible tribute to their efficiency. In addition to all the multitudinous duties to which the lecturer had referred as falling to the Indian Marine to perform, there were lighthouse services and the management of ports. Despite the fact that there were almost infinite opportunities for being subjected to unfavourable criticism, there were few branches of the public

services in India which had been less criticised, so far as technical efficiency was concerned, than the Royal Indian Marine. He was confident from his knowledge of them, and of the general attitude towards them of the instructed public, that they were opening a fresh and even more distinguished chapter in their long history.

MR. C. H. BOMPAS, C.S.I., said he was almost ashamed to take part in the discussion, as almost all he knew about the Royal Indian Marine was what he had just learned fron the lecture. He remembered reading an account of the survey of the rivers of the Sundarbans conducted by officers of the Indian Marine Service, from which it appeared that it had been almost impossible in those days to set up a theodolite without having it knocked down by a man-eating tiger. He supposed everyone had been more or less interested in the proposal, which was now taking shape, of India having a navy of its own, and one was interested to hear from the lecturer that, as a result of that, the service would be thrown open to the Indians of other races than those on the Bombay side. Most civilians' idea of the Indian sailor was the Lascar on the P. & O. and B.I. boats. They mostly came from Bengal, and he could imagine that they would show in the future that they were as good sailors and fighters as the Bombay men. Personally, he had had to administer relief funds during the War, part of which had been devoted to making grants to Lascars whose ships had been torpedoed. The deaths of Lascars on torpedoed ships had run into very large numbers, but it was true to say that there had not been a single case of a Lascar who had been saved from a torpedoed ship who had not immediately volunteered for another voyage; and he knew many whose ships had been torpedoed more than once.

CAPTAIN H. T. A. BOSANQUET, R.N., remarked that it was impossible in a general survey of the history of the Indian Marine for the lecturer to mention any details of the manning of the Service, but personally he would like to recall the services rendered by the Marine Society of London during the years 1757-1861. During the whole of that time the recruiting of the European Service had been carried out by the Marine Society from the boys from their training ship; and in those years they had sent altogether to the Bombay Marine and Indian Navy 3,760 boys. The Marine Society still carried on its work at Greenhithe, but of course its connection with the Indian Navy had been severed since 1861. It seemed to him that it would be very desirable if, under the re-organisation scheme, boys from the *Warspite* at Greenhithe could in some way be sent out to India to form the European crews of the existing Indian Navy. He hoped that point might be considered.

THE CHAIRMAN said it had long been a desire of his before he had gone to India that the Indian Navy should get back on to a combatant basis, and that the old Indian Navy should once more be revived. He had read Captain Low's "History of the Indian Navy," in which were described all the past exploits of the Indian Marine, to some of which Sir Edward Headlam had referred that afternoon in his interesting lecture. A good many of his (the Chairman's) ideas had been got from an old officer, now dead, who had himself been a great historian and a most enthusiastic supporter of the revival of the Indian Navy—an officer whose name he hoped the Indian Navy would never forget, namely, that of Admiral Sir Cyprian Bridge. Sir Cyprian Bridge, on every occasion that was open to him, had always done all he could to revive that old Force. Sir Cyprian had talked to him a good deal about it, and it was what he had told him, and what he had been induced by him to read, that had brought him first into touch with the subject, and that

had led him to interest himself in it. Before Lord Rawlinson had started investigating the question of the Indian Navy, he himself had gone in to the matter to a certain extent, and he had taken the opportunity at Calcutta to speak to many of the officers of the Mercantile Marine about the whole subject of the Indian as a seaman; and it had been very pleasant to hear the very high tribute which all of those officers had paid to the Lascars and to the Indian seamen who had served under them. They had said that all that such men required was good leadership, and that if they got that they would follow one anywhere. The Indian Marine and the Indian Navy in the old days had consisted, as the lecturer had said, of small ships, and the crews had been better fitted to that kind of ship than to the larger ships which had now become such horrible complicated instruments as hardly to be ships at all. The Indian Marine would have a very wide scope for its duties; it would have as wide a scope in the future as it had had in the past. There were many occasions on which there had been no British ship flying the Royal Ensign in Indian waters at all; in fact, the first appearance of a British Squadron in Indian waters had been in 1746. From 1612–1746 piracy had been kept down in the Indian waters entirely by the efforts of what was now called the Indian Marine, and also after the British Squadron had returned home the Indian Marine had once again taken on the whole of the work of the defence of the trade of India, and he had no doubt that if unfortunately another war were to come it would be found that the Indian Navy would again have those duties put upon it and would carry them out as efficiently as it had done in the past. It was a very encouraging thing, in talking to a large number of Indian gentlemen in Delhi and Calcutta, to hear them express such a cordial desire that there should be a fighting navy belonging to India. The bill for such had been turned down in a purely factious spirit. The great bulk of people, he thought, were strongly in favour of it; and although the title of the Royal Indian Marine remained at the moment he believed that it would not be many years hence when it would be called the Royal Indian Navy, and he for one looked forward very much to that day.

He asked the audience to accord a very hearty vote of thanks to Sir Edward Headlam for his very interesting lecture.

The vote of thanks having been carried unanimously, the meeting terminated.

CORRESPONDENCE.

MUSEUMS AND EDUCATION.

The paper by Sir Henry A. Miers on "Museums and Education" serves to show the increasing importance of museums to education, both to the student and to those who have passed the student age.

The change in attitude towards museums, which are no longer regarded as depositories for relics, but as living, vital organs of the community which they serve, is becoming general; and what is being done in England along these lines is being carried out throughout the whole world.

The Franklin Institute of the State of Pennsylvania, in combination with the Poor Richard Club, has recently formed a Trust known as "Benjamin Franklin Memorial Incorporated," whose purpose is to build a museum which is to be used for the promotion of science and the mechanic arts. Any of your readers, who may be interested to have complete details of this plan, I would refer to an article by Mr.

Howard McClenahan, Secretary of the Institute, in the December issue of the *Franklin Institute Journal.*

What is being done in Philadelphia is being planned in many cities throughout the nation, with an interchange of material, and a resultant diffusion of knowledge. There is hope of a spread of interest to the rural sections, bringing knowledge, uplift and interest to all.

WILLIS A. NAUDAIN,
M.Frankl.Inst., F.R.S.A.

NOTES ON BOOKS.

ANIMAL DRAWING AND ANATOMY. By Edwin Noble, F.Z.S. London: B. T. Batsford, Ltd. 10s. 6*d*. net.

I once heard a young man ask an eminent painter how he would recommend a student to set about training hand and eye. The painter picked up the teapot over which we were talking and said: " Look at this for a minute, then go away and draw it from memory." The effort of consigning to memory as accurate impressions as possible is most important in drawing. With animals one *has* to memorise, because, except when asleep or stuffed, they do not keep still. And when stuffed they differ in certain respects from their living brethren: for instance, in the case of sheep, there is a picturesque cracking in the woolly areas in the live animal which is not found in the dead, the skin having ceased to exert its characteristic strains.

Mr. Noble's book is a sound guide to animal drawing, and agreeable to read; it is not of the learn-to-draw-in-six-lessons and get-rich-quick order. His anatomical sections are especially useful. He also traces the development of various animals from their earliest forms as known to science. It is interesting to note that Prjevalski's Horse, found in Siberia to-day, may be a living type of the original wild horse of Europe. Mr. Noble's drawings of a shire horse and a hunter, showing the different ways they carry their tails, illustrate the descent of the thoroughbred from Arabian ancestors.

The æsthetic possibilities of animals have been recognised by artists in the European traditions, but on the whole not much exploited. Prehistoric man, as at Altamira, and early historic man, as in Crete, took animal forms for the basis of remarkable designs. There are superb horses on the Parthenon Frieze—with manes of the Prjevalski type. The animal groups of Lysippus, famous in antiquity, have been lost. As Mr. Frank Brangwyn says in his preface to Mr. Noble's book: " We find animals and birds often represented in the decoration of many of the buildings of the past, in mediæval churches, and in heraldry, tapestry and all forms of painting and decoration." But neither the middle ages, which were unsentimental about animals on the whole, nor the Renaissance, which was overwhelmingly preoccupied with man, quite gave animals their æsthetic due.

One calls to mind the amusing horses and dogs of Uccello, the St. Eustace of Pisanello, the apes, for introducing which into a Marriage at Cana Veronese was reprimanded by the Venetian Signory. Later, Cuyp brings animals well into the foreground. He was a great painter; and in spite of the English love of sport and of animals—needless to say, two quite different things—our most prominent

animal painter, Landseer, was far from being up to the standard set by the Dutchman.

From the point of view of applied art, animals have provided patterns since remote Egyptian times. Mr. Noble's book will be found useful by the aspirant craftsman as well as by the student of drawing for its own sake.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 8.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Major-General Sir Fabian Ware, "The Work of the Imperial War Graves Commission."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.30 p.m. (1) Messrs. J. Baker, T. J. Ward and H. F. E. Hulton, "The Incidence of Infection in Brewery Worts and Beers." (2) Messrs. J. Baker and T. J. Ward, "Saccharomyces Sesp inans."

Chemical Industry, Society of, at Burlington House, 8 p.m. (1) Mr. W. Gordon Adam, "Free Carbon Formation in Tars and Pitch." (2) Dr. D. D. Pratt, "Constituents of the Aqueous Liquors of Low Temperature Tars."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Annual General Meeting. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. G. H. Gardner, "Notes on the Inspection of Public Works."

Farmers' Club, at the Whitehall Rooms, Whitehall Place, S.W. 4 p.m. Mr. A. E. Magee, "The Marketing of Milk in Relation to the Incidence of Production."

Mechanical Engineers, Institution of, Storeys Gate, S.W. 7 p.m. Joint Meeting with Students' Sections of the Institution of Civil Engineers and the Institution of Electrical Engineers.

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12 Great George Street, S.W. 8 p.m. Mr. B. W. Adkin, "The Education of a Young Surveyor."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. J. H. Estill, "The Port of London."

Victoria Institute, at the Central Buildings, Westminster, S.W. 4.30 p.m. Major Lewis M. Davies, "The Philosophic Basis of Modernism."

TUESDAY, APRIL 9.. Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Messrs. H. S. Rowell and O. G. Williams, "Automatic Spark Advance."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. Hall, "The New Piccadilly Circus Station."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Annual General Meeting.
At the Engineer's Club, Manchester. 7 p.m. Annual General Meeting. (1) The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages." (2) Mr. J. A. Kuyser, "Recent Developments in Turbo Generators."
At the Royal Technical College, Glasgow. 7.30 p.m. Annual General Meeting. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking." (Electrical Research Association Report).

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Arthur Duckham, "Australia: Some Economic Problems."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. "The Relative Merits of Pulveriser Fuel and Mechanical Stoking and their Application for Marine Purposes." Mr. W. E. Woodeson (Pulverised Fuel), and Mr. J. S. Gander (Mechanical Stoking).

North-East Coast Institution of Engineers and Shipbuilders, at the Cleveland Institute, Middlesbrough. 7.30 p.m.

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Dr. L. Dudley Stamp, "The Oil and Gas Fields of Burma."

Zoological Society, Regent's Park, N.W., 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, APRIL 10.. Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. (Meeting of Wireless Section).

Food Education Society, 29, Gordon Square, W.C. 3 p.m. Dr. Harry Campbell, "Common Errors in Diet."

Fuel, Institute of, at Burlington House, W. 5.45 p.m. Annual Corporate Meeting. Major W. Gregson, "Some Notes on Waste Heat Recovery."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

United Service Institution, Whitehall, S.W. 3.30 p.m. Commander H. M. Denny, "Destroyers in the War."

THURSDAY, APRIL 11.. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. M. Lapresle "Wind Tunnel Methods of the Eiffel Laboratory."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. J. H. Johnson, "System of Account in the Wardrobe of Edward II."

Mechanical Engineers, Institution of, at the Technical College, Cardiff. 6.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture).
At the Engineers' Club, Manchester. 7.15 p.m. Annual Meeting. Mr. R. D. Gauld, "Factors in the Design of Steam Locomotives."

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Annual General Meeting.

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Dr. F. C. Toy, "Some Optical Properties of Paints and Pigments."

FRIDAY, APRIL 12 Astronomical Society, Burlington House, W. 5 p.m.

Chemical Industry, Society of, at Milton Hall, Manchester. 7.30 p.m. Annual General Meeting. Mr. T. R. Woolaston, "Suggestions in Steam Raising."

Chemical Industry, Society of (Chemical Engineering Group), at Birmingham. Dr. C. M. Walter, "The Design and Operation of Gas Heated Furnaces."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Mr. E. J. Wayland, "The Later Geological History of the Equatorial Lakes in Uganda."

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Mechanical Engineers, Institution of, Storeys Gate, S.W. 7 p.m. Mr. F. E. F. Durham, "Pumping Plant."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Mr. W. S. Burn, "The Development and Performance of the Richardsons-Westgarth Oil Engine."

Oil and Colour Chemists' Association, at Milton Hall, Manchester. 7.30 p.m. Annual General Meeting.

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m.

Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Paper by Mr. J. E. Peacock.

SATURDAY, APRIL 13.. United Service Institution, Whitehall, S.W. 3.30 p.m. Captain R. A. Hornell, "The Royal Navy of To-day."

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FRIDAY, APRIL 12th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 17th, at 8 p.m. (Ordinary Meeting.) F. E. LAMPLOUGH, M.A., late Fellow of Trinity College, Cambridge, "The Properties and Applications of 'Vita' Glass." PROFESSOR LEONARD ERSKINE HILL, M.B., F.R.S., Director of the Department of Applied Physiology, Medical Research Council, will preside.

COMPETITION OF INDUSTRIAL DESIGNS.

By kind permission of the Board of Governors of the Imperial Institute, the public exhibition of works sent in for this year's open Competition of Industrial Designs will be held in the Exhibition Pavilion of the Imperial Institute, South Kensington, S.W. Full particulars of the Scholarships and prizes offered in connexion with the Competition can be obtained from the Secretary of the Royal Society of Arts, Adelphi, W.C.2. Applications for forms of entry, labels, and instructions must be sent to the Secretary of the Society between May 1st and May 11th and the last day for receiving entries is May 27th. The designs entered for the Competition are to be forwarded to the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W., between June 10th and June 12th, and after the judging, which takes place in July, the accepted designs will be exhibited to the public at the Imperial Institute from August 3rd to September 1st (Sundays included).

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 20TH, 1929.

PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., in the Chair.

The following Paper was read:—

HISTORY OF THE DEVELOPMENT OF FAST DYEING AND DYES.

By JAMES MORTON

(Chairman, Morton Sundour Fabrics, Ltd., and Scottish Dyes Ltd.).

PART I.

Textiles are a world of their own, and it is only those who have been directly concerned with their production or distribution that can know their inner history. But even the lay-man or woman knows that within the past two decades what is practically a world-wide revolution has taken place in the standard of colour as applied to woven fabrics. As late as 1900 there was absolutely no standard of fastness for colour in textiles. These were made, and sold and bought, not expected to last in colour, for it had grown to be taken for granted that somehow things could not be otherwise. What do we find to-day? The public have been educated to a standard totally different, and have been led to expect and demand the colours of their fabrics to be as sound as the fibres of which they are made—a tremendous revolution in this special sphere within so short a period.

Some manufacturers and distributors have questioned the commercial wisdom of raising the standard to so high a level and of offering guarantees for fastness of colour in ordinary textiles; and as I am the original sinner, perhaps it is fitting that I should shoulder the responsibility and give the story of how it all came about. If what I have to say is largely of a personal character, or has reference mainly to our own business, I know you will excuse it, for, I gather, it is this personal experience and development that is the origin of my being invited to give a paper before this ancient and learned Society.

The story is a very simple one. Our firm had been makers of furnishing fabrics for some thirty or forty years—curtains, upholstery fabrics, carpets and such like. About 1902, after we moved a branch of our works from Ayrshire to Carlisle, I had been interesting myself in the making of certain special tapestries. We did not then do our own dyeing, but got what was the best general service of the trade from old-established dyers, and I was responsible for the colouring of these tapestries. One day in Regent Street, London, I happened to be making the usual survey of Liberty's windows, and these par-

ticular tapestries caught my eye. But they had changed so radically, that I scarcely recognised my own handiwork. Certain colours had gone so much that the balance of my schemes had been completely upset, and I went in to enquire what had happened to these goods. I was told they had only been in the window for about a week. Here, indeed, was a revelation to me. I had no idea that we were being supplied with colours that were so fugitive, and I made a resolution. What was the good, I argued, of using valuable materials and of spending time over carefully considered colour schemes, if in practice everything was to be upset by a week's exposure to ordinary sunshine, the very purpose for which the goods were made? If this could not be remedied, I felt I should want to look out for a new job.

But I must first learn whether we were unique in our position, and whether there were not other fabrics on the market that behaved differently from ours on exposure. I stayed in London a few days longer, and collected from friends in the trade manufacturers' sample books of fabrics of all kinds—velvets, tapestries, damasks, dress goods, window hollands—the productions of our own country, of Germany, France, and whatever came into the London markets, so I went home with parcels of books representing many hundreds, probably thousands, of the existing colours of all classes of fabrics, chiefly cottons, mercerised cottons, linens and some silks.

Our home was then on Beacon Hill at Penrith, and our gardener had just filled a new greenhouse with young tomato plants on the side of a sunny hill. To his chagrin, next morning I told him that I was afraid I should have to upset his plans, for I wanted complete possession of that glass house. So I had those many hundreds of colours duly mounted on cards with their surfaces half covered and half exposed, and a warm, humid atmosphere maintained. Our own fabrics were exposed with the others, and I should soon see what was the state of the colour element in fabrics as they were being supplied to the trade of the day. The result was most staggering. In many cases quite deep shades, on expensive velvets, for example, became almost white in a week. Careful notes were made on every card at stated periods, but in a few weeks there was not much more to record—it was a veritable "Flodden Field," with the "Flowers o' the Forest a' wede awa'." Only a very few of that vast array held up any head at all after a few weeks' exposure. It was indeed a revelation.

As I have said, we did not then dye our own yarns, and I was to a great extent ignorant of the composition of the dyes used; but it was evident that the whole colour side of our industry was in a hopelessly demoralised condition and that dyers supplied, and manufacturers and merchants were willing to accept, anything that coloured a fibre or a fabric, regardless altogether of its behaviour afterwards. This was without any question the condition of things at the time I am now speaking of, on practically all fabrics composed of vegetable fibre, a most humiliating position for anyone who had respect

for his trade or any real interest in the goods he was making, and surely most unfair to the public, who were his ultimate customers. So I determined to attack this state of affairs—a big job enough, as you can imagine. But what was there to go upon ?

As I looked at the débris of fallen colours, one here and there stood out. Certain elements in others seemed to be fairly sound. I must get to know just what types of dyes these were, and whether we could begin to build on these as a foundation.

While making this survey of colours, it so happened that I was working on a new combined weaving and printing process in which I required the use of certain coloured yarns that would stand an after-resist printing process. In this connection the representative of a certain Scottish firm brought to me some pinks, " Blush Pinks," he called them, which he affirmed would " stand anything." I doubted the statement very much, especially with the experience I was just having in my tomato house (and as a matter of fact, the blush of the pinks did prove somewhat evanescent). But the phrase " stand anything " caught my imagination, and the idea flashed across my mind—I can remember the very spot still—what if it were possible to get colours, even some colours, that would " stand anything." What a splendid triumph it would be, and what words with which to go to the trade with, against all that array of mock dyes that was obviously holding the field at the present day. So I set my face towards this goal without delay.

In the firm which this traveller represented I learned of a young colour chemist, son of the head of the concern. I sought him out, and unfolded to him the scheme I had in my mind. I took him to see my " Flodden Field," with its few survivals, and we then began a long, constructive campaign that has, I think it will be admitted, left its permanent impression on the textile trade of the world. This was in 1903.

My scheme was to arrive at a range of colours, even a small range, that could be absolutely relied upon, or as nearly absolute as practical purposes could expect, and to make from them certain types of fabrics that we should be prepared to guarantee against fading from sunlight or from ordinary washing. So we set about dyeing many hundreds of colours in every conceivable way that would tend to secure fastness. These we exposed and tested diligently, week by week, and month by month, learning as we went along. After a certain number had given promise of the necessary qualities, I made up cards of those, which I sent to a friend in India to be exposed on the roof of his house in the Punjab. I made up several sets of those cards, having alongside them corresponding shades of ordinary dyes, with instructions that they were all to be exposed uniformly, and one of the sets was to be returned to me after the expiry of each month. This gave me the behaviour of each group from one to several months' exposure under the blazing sun of India, while at the same time we were having similar tests under our own climatic conditions. From these

tests I was able by the summer of 1904 to get as many reliable colours as formed a quite respectable palette, and by the autumn of that year we had them made into tapestries that were put on the market with a guarantee that any goods fading or failing to stand ordinary laundry wash would be at once replaced. That, I believe, was the first time in the history of textiles that such a guarantee had been given, and it made a great impression in that particular department of the trade.

To give the event proper prominence, and possibly to satisfy a certain Scottish caution, I thought it advisable that those goods should be handled and announced at first by one prominent distributor only, and on my putting the matter before the directors of Messrs. Liberty in London, they at once grasped the significance and value of the idea. These guaranteed goods were first announced and sold by that firm in the autumn of 1904, and we gave them the monopoly for this country for a certain term.

It is interesting now to look back on that modest palette, and those of you who know anything of the history of dyes must wonder how we could launch on such a venture at that early date. But the Alizarines were good friends in those days, and if kept deep enough in shade, and dyed with care and real knowledge, they could be relied on for reds, deep wine colours, and such like. Then we had to recognise the value of some of the old mineral colouring matters which gave us some buffs and light browns that were very useful. But what about blues and greens? For indigo on vegetable fibre we found to be far short of the standard that would justify any sort of guarantee. Our rescue in this direction came from quite a new source. As you chemists will remember, it was just at this time that the first of the Vat colours were being put on the market—Indanthrene blue and yellow, also a grey. These proved the saviours of our scheme, and but for them we should have had to be content with a very limited and uninteresting palette indeed. But even here it was by no means plain sailing. Vat dyes were new and very sensitive and difficult to apply with any degree of levelness that would be suitable for our types of cloth. They had never been used in commercial bulk anywhere, and in our own country practically not at all, so that their manipulation was a piece of interesting new work.

To proceed with our story, this elaborately tested and selected range of colours was dyed on yarns for us by a firm or firms of dyers in Scotland under special agreement. They were woven into fabrics on our looms in Carlisle, mainly tapestries of cotton, mercerised cotton, and linen, with some special colours in wool that we could absolutely rely upon. And thus was launched this first ship of our new venture. It met with immediate response. The colours stood up to all that we had claimed for them, and in due time our first goal had been reached, for we had got to the ear of the public the fact that it was possible to obtain textiles that could really be relied upon for colour fastness.

The problem of marketing on a broader scale soon claimed our attention. As I have already mentioned, we had had the great advantage of having our message proclaimed first by the firm of Liberty, and it was a valuable platform from which to make such an important new announcement. It brought the fabrics into much prominence and aroused the curiosity, if not the covetousness, of other buyers, both at home and abroad. But the fabrics for this firm, especially at the time of which I speak, were necessarily of an exclusive type and appealed to a clientèle where the price factor was not of such importance. This, however, also meant a necessarily limited trade. So when our term of monopoly expired and we set out to cater for a more general trade, price had obviously to play a much more important part. The great problem now was whether we could so convince the general buyer and the general public of the soundness and value of the fast dyes that they would be prepared to pay the very considerable extra price. We must study the science of selling. We decided that a brand or trade-mark must be had by which our goods would be known, and that a campaign of preaching and publicity would be necessary before the fabrics could be generally accepted as the standard of the trade. So we invented our trade-mark of *Sundour,* made up of the word " Sun " and " dour," the latter an old Gaelic word meaning water, and also in Scottish meaning stubborn or hard to move. In our publicity work we found of tremendous help those exposures that had been so exhaustively made. Our printer friends in Carlisle made a most useful coloured lithograph of those cards of exposure whereby we could show at a glance the comparative results of ordinary dyes and our *Sundour* dyes, the former showing almost white in three weeks while the *Sundours* had stood firm at the end of their seven months' exposure.

It was essential, as you will realise, to have some visible and tangible proof of value, for you must remember that we had to ask about 50% higher price for fabrics that looked just the same to begin with as the fabrics with which they were competing. It was indeed asking much good faith on the part of the buyers. But our firm had behind it a long-standing reputation for reliable goods,—thanks to the work of our fathers. There was also already behind these guaranteed fabrics about two years' history with a firm of repute, and it was at this time that I made an exhaustive tour personally among our customers throughout this country, as well as from the East to the West of Canada and from the West to the Eastern States of America. It was the first missionary journey on the gospel of Fast Colours. I had with me specimens of my special exposures as a visible object lesson, also numbers of washing tests. The reality of the new factor got home to the buyers, and from that time the growth has been what you all know it. Within a year or so we had not only all our own available looms occupied on fabrics made with these fast-dyed yarns but we had many scores of looms working for us on commission.

Hitherto we had only tackled the dyeing of these special colours on yarns for cloths with which we had become more or less identified. By this

time I felt that we were, perhaps, reaching the limit of the trade that could be done in this particular field—mainly tapestries and fancy types of hangings. But there arose a great demand for plain dyed piece goods. It was a business of very great volume in Lancashire, and I felt that, if we could adapt our special features to this particular branch, it would enable us to tap the grey cloth production of Lancashire and would give us fabrics on a much lower basis of cost that would appeal to a vastly greater public. In the meantime, stimulated, as I think the makers in Germany would willingly admit, by the market we had helped to create for them, the scope of dyes of the Vat type had greatly increased ; but their application had been confined to yarns, and I realised the enormous value that would accrue if they could be applied to the vast grey piece trade. This involved a set of problems that had never yet been tackled, and here a new chapter in our story begins.

These problems were of a kind that could not be undertaken by our friends in Scotland who had been dyeing our yarns, so I decided that we should make these new developments in dyeing within our own works at Carlisle. This involved the starting of a chemical side of our business. It was in the year 1909. As a preliminary, I visited personally the Principals of our three main Technical Colleges—Leeds, Bradford and Manchester—stated my problem and asked for their recommendation from among their present or past students who might be available for our important post. It was an interesting and instructive time, and I ultimately fixed on the recommendation of Dr. Knecht of Manchester, in the person of Dr. Teltscher, a graduate of Heidelberg University, who, besides having taken his Ph.D. there in pure science, had taken a tinctorial and textile course at Manchester, as well as a short similar course in Germany. He became known to many in Carlisle and delivered several interesting scientific papers there, and was an active and interesting personality among us till he left for Vienna on the Sunday before the outbreak of War.

With his collaboration we ultimately worked out a special process for the application of Vat and other colours to plain cloth, from laboratory models. These we afterwards developed into works' plant from our own drawings. From these we dyed and issued from our works in Carlisle the first whole or plain vat-dyed goods in this country, and the first practical production of its kind, I believe, in any country, for Germany had not yet reached the stage of applying these colours in that form.

The introduction of these plain dyed fabrics made a much greater impression on the market than anything we had done before. They appealed to a much wider public and, as you can easily realise, to offer a perfectly plain cloth guaranteed against fading was a much bolder thing than to offer a multi-coloured patterned fabric—any fading would be so instantly visible. It got Lancashire manufacturers by the ears—who would ever think of guaranteeing plain dyed cloths such as they had been turning out by the mile in their easy way all these years—and they foretold early disaster to the firm that would venture on so wild a scheme.

We went our way. The orders rolled in and the machines went up till we began to be felt by the big Lancashire and Yorkshire makers. And when they realised that the road we had taken did not seem to be leading to utter destruction, they began to offer us a little of their company, so that to a small extent before 1914, and in a much greater degree during these later years, we have had many companions on the way, here, and even more largely in America, each decorated with his own peculiar badge or banner, as like the original as they could go—the word " Sun " or " Sol " or " Dour," with every variety of prefix and affix—but none of them just the plain *Sundour*. From a perusal of the trade papers one would indeed think we had become a people of sun worshippers !

We have made welcome all this company so long as they were leal and true to the standard. For what is the meaning of it all ? It means that the public apathy has been dispelled, and if manufacturers are to get their share of the trade, they must now work to a completely new standard of colour. The public has at last been taught to demand, because they know they can get, the colour element of the fabrics they use as stable and reliable as the fibres they are made of—which is indeed the goal of the crusade we set out upon those years ago.

The realisation of all this sustained a rude shock in the very height of the effort, and while we were still almost alone in the field. The threads of our web were suddenly snapped, and the gathering-up of these threads and the re-starting of the web will be the subject of the second part of my story. But before I start on that, it may be interesting for you to know something of the progress we had made up to that date and some of the satisfaction it had already brought to us.

By 1914, though we had had a progressive business in many departments of textiles for some forty or fifty years, this *Sundour* section had become by far the largest and not the least lucrative. And what about reputation ? How had the guarantee fared ? This is most interesting. At first we felt that it would be only prudent to lay aside a certain reserve out of profits against goods that were going out in such quantities with a guarantee for every yard, but after the first two years we found that this was entirely unnecessary. I do not say we had no complaints, for much may happen where so many operations are subject to the human factor. But our tests were so rigid, and our decision to use at all times only the best procurable dyes by the best known processes, regardless of cost, was so effective, that the percentage of misfits in a year was infinitesimal and therefore quite negligible. As to reputation, I could read many letters that came to us from all parts of the globe testifying to the wonderful behaviour of our fabrics. They were a great encouragement to us in those early days. To give many of them would only weary you, but as a matter of scientific interest to some of the chemists here, it may not be out of place to read one or two of these comments, just to show what properly

dyed colours on sound cloths can stand. Take this from smoky Pittsburgh, U.S.A., written from the chief store there, in October, 1910, to our New York house :—

"Feeling quite sure that you would be interested in regard to the wearing qualities of your *Sundour* fabrics we are sending to you a strip used as a window panel. Said panel has been in use for the past five years on the sixth floor window, southern exposure, and has been washed twenty times or more in our own laundry in the ordinary way. Prior to cleaning, these curtains on each occasion were black with greasy soot common to this locality, which heretofore has been the cause of taking both life and colour out of every fabric tested.

"Would like if you would carry a surplus of this *Sundour* cloth in New York as we are constantly running out of some of the colours. Will guarantee taking double our mail order if this will be any inducement to you to carry stock of our colours."

This Nigerian experience may be of special interest, written to a friend in London and forwarded to us :—

"Ten months ago a friend of mine called here on his way out to Southern Nigeria. He had been there for a number of years, coming home at intervals. On seeing *Sundour* fabrics he was inclined to pooh-pooh the idea of their being fadeless and offered to fade them for me. I gave him samples, which I have received back this morning. He had split them in two, locking one set in an air-tight case used in the jungle, and exposing the other to sun, wind and rain for seven months close to the equator. He writes now to say that he is a convinced believer, and the samples sent back speak for themselves. These I am sending to you as I thought they would interest you."

The following is a rather romantic episode of some *Sundour* curtains which we have now at the works. They were brought back by one of our directors who was visiting a friend in Yorkshire, and for the purpose of this paper I wrote this gentleman to give me the story of them. This is what he says :—

"The curtains you ask about were supplied in April, 1913, and hung at the windows of our yacht. In 1914 the yacht was given to the Admiralty, and was in constant use all through the War in various waters. When the boat was sent back, the curtains, along with the other things, were black and greasy. My wife had been rather partial to those curtains, and thought, why not try a washing of them ? After thorough washing they were re-hung and looked as good as new. This was in 1918, and they have been worn constantly since on all our cruises, and would be now, had not Mr. Murray, on his visit to us this summer, 1928, begged to have them as a *Sundour* keepsake."

But one must not hurrah too soon ! We never know what may be in front of us. A few months ago some cloth came back with complaint that it showed fading. We investigated and found that it had been supplied some nineteen years ago. The chief defect was that the fibres were badly chafed, but after washing, the colours were found to be so good that we kept the cloth as a splendid proof of stability, and sent the customer new material. I need not add, perhaps, that this communication came from Aberdeen !

Into quite another department of life the fame of *Sundour* colours seems to have found its way. It may be of interest to tell that in the famous Army manœuvres in Germany in 1913, the capes and caps of the Emperor, his sons, and Field Marshals, were all made of *Sundour* material dyed and woven at our works in Carlisle, and supplied by Messrs. Burberry, because they had been found to stand their most rigorous weather tests.

Just one other incident relating to Germany, which I must give at this stage, mainly because of a rather interesting sequel, which, however, does not come until much later on in my story. We were on very good business terms with the German dyemakers, and in the Vat section would be by far their largest customers in this country. We had collaborated with them a good deal with a view to getting materials that would meet our very special requirements. In the autumn of 1913 there was an important new phase that I was keen to develop. It was arranged that I should spend some time over there with our head chemist in order to go through some experiments, and we had a most interesting trip. Our time, I may say, was all spent in the application laboratories, the actual manufacturing sheds being sacrosanct. At the Badische works at Ludwigshafen we had a specially interesting time. As it was from these works that we had been drawing most of our supplies during all those years, my name and our affairs seemed to be somewhat well-known to them, and they had by them many specimens of our productions as a matter of technical interest. In showing us round their Hall of Honour, Dr. Bohn, I think it was, pointed to an empty niche in the gallery. In a jocular way he explained that that niche was being reserved for Mr. Morton, as they recognised that it was to him more than to anyone living that they were indebted for the commercial development of these Vat colours—a nice little compliment with a sequel of which, as I have said, you will hear later on.

I took the results of the experiments of our sojourn home with me. They were going through their usual tests, and for the next few months we were preparing for this new development. The holidays of July came, and then it was the August of 1914 and—the scene was changed.

PART II.

It is difficult to know just how to begin this second part of my story, for I sometimes rub my eyes even yet, and wonder whether it is not all a dream and if it is really true that one has been responsible for what is now known as Scottish Dyes, with its huge buildings and railway avenues spreading over some fifty odd acres of land, dealing with thousands of tons a year of raw products to be converted into intermediates and dyestuffs of the most complicated types, by dozens of skilled chemists, with hundreds of chemical process men, and employing something like a million sterling of good capital.

Much has been said at different times as to the condition in which manu-

facturers in this country found themselves when suddenly deprived of the supply of German dyes, but from what I have already said, you will agree that no firm, perhaps, was more hardly hit than we were. While we had our own special plant and processes of application, we had grown to be almost entirely dependent on Germany for the supply of these special products. We had developed a big and progressive world trade, and moreover, we had just formed that section of our business into a separate company for its further development—Morton Sundour Fabrics, Limited. Should we have to pull down our Fast-Dye Flag, the work of all those years? Not except under direst necessity. But just what to do? In spite of the dislocation of everything by War, trade somehow kept coming in, and stocks of dye materials were rapidly diminishing. No one among us had ever troubled to know the chemistry of these dyes—we had had enough to do with application. Very little literature was available. But as in other things at that time, this crust of ignorance must somehow be broken, and this was our plan.

In the last resort we could again revert to some of our earlier types of dyes, materials for which were all available in this country. But as in the earlier days, the crux again was the blues and the yellows, and their combination into greens. If we could get hold of just these two dyestuffs we could carry on, and our flag should not go down.

Our head dyer, though he was not a University man, and would not be considered a very profound or exact chemist, had a certain flair for things chemical, in many directions, that came in most opportunely at this juncture, and was of great value to me in those early stages. We traced out the synthesis of those two dyestuffs, and found that they were both derived from 2-amino-anthraquinone, a word that was the purest Hebrew to me at that time, but which for many days to come I had to assimilate with my morning coffee. The blue was apparently got by fusing this 2-amino with caustic potash, and the yellow by treating the same substance with antimony-pentachloride in nitrobenzene.

This mysterious 2-amino-anthraquinone was derived from anthraquinone-2-sulphonic acid sodium salt, more commonly known as "silver salt," which I learned was the basis of alizarine. Here, I felt, was a clear ray of hope. At Silvertown, on the Thames, was the British Alizarine Company, who had been large makers of alizarine for many years, and I felt, surely here were the people to tackle the manufacture of these essential dyestuffs—they were already half-way there. With this new knowledge I got into immediate touch with this company. I was in hopes that they might have already started on the problem. But this only resulted in my being told that they had done nothing in the direction of these colours; nor could I persuade them to consider doing so.

I then visited the other dye-making concerns to learn whether they were doing, or had intentions of doing anything towards the manufacture of these Vat

colours, but their reply was in the same strain. They were busy on the manufacture of general dyestuffs, so much in demand, also with essential acids for War purposes, and they could not consider taking up anything so intricate or exclusive as the Vat dyes.

I went home to " chew the cud " and to see whether, to all our new activities, it would be possible to add this further, difficult problem. For by this time we had already undertaken, among other things, the manufacture of a large number of army blankets, so urgently wanted just then. We decided that if we could procure the silver salt, we really would set out and try to do the rest of the processes ourselves. I was determined that we should have the blue and the yellow, though they should cost us their weight in gold. But it was imperative to get more definite and detailed information as to manufacture. There were no books on these recent dyes, and Patent specifications were not to be had. The only source of information was the Patents Library in London, and I was lucky in procuring there the services of a good chemical reader, who spent many hours and days extracting for us the necessary details of the various patents involved. Thus we were enabled to see something of the task before us.

I then approached again our friends at Silvertown—the British Alizarine Company—this time for a different purpose. I explained my project, and the worthy Dr. Bendix looked mildly amused. In the end, however, he let me have my silver salt, and from the smile on his face, I am sure he felt that it was like giving a schoolboy what he asked just to humour him, and that no more would be heard of it. I got the precious silver salt home, and our fun began. We had now to convert it into the 2-amino-anthraquinone which, as I told you, is the basis of our coveted yellow and blue. But what did this mean ? It involved one of the most difficult operations in chemical manufacture, and one that had never been done in this country—indeed the means for it did not exist. It involved the heating of the silver salt under a pressure of from 600 to 800lbs. per sq. inch or 35 to 40 atmospheres with ammonia at a temperature of from 180° to 200°C. By great luck we had available an old little autoclave made of Krupp steel, which had been procured years before for quite a different purpose. It held about 1½ litres, with solid cover held down by clamps, and what was best of all, had a splendid all-steel pressure gauge and safety valve.

One cannot go into all the interesting and exciting details of these first days and nights, but suffice it to say that we at last got our little autoclave to yield us quite a respectable 2-amino-anthraquinone, with its long orange needles, or crystals, and by early November, just three months after War began, we had actually produced Indanthrene Yellow G., and a few days later, Indanthrene Blue—only a few grammes of each, and I am afraid, not of the purest, but we had worked out the processes and knew something of the road we had to travel, or, shall I say, as much of it as was good for us then to know.

We had then to consider plant, and it made me smile, when looking up my notebook the other day in connection with this paper, to read the modest list of requirements that was to form the first chemical plant in this country for the making of Vat dyes—a few hundred pounds sterling in all. The chief problem, as you may imagine, was the autoclave. We decided to make it of a size to hold a charge of 8 cwts., and a steel vessel of that capacity to stand a working pressure of 40 atmospheres at about 200°C. had never been thought of in this country. However, with the help of a good local engineer, we made as careful a design as we could for an autoclave complete with stirring gear, pressure gauge, thermometer, tube pockets, safety valves, etc., and the casting was put into the hands of a London company to whom we had been specially recommended. It was a long wait for this vessel, but meantime the other plant was getting ready, and we kept getting experience with our little autoclave, making a charge every day without fail, and the cupfuls of blue and yellow colour thus got were not to be despised. At last, some time in January, 1915, the wonderful autoclave was ready, and I went south to see the hydraulic test. But it was no good. The material used had been too porous; moreover it had other faults in construction, where the makers had departed from our design, and we decided that we could never take the risk of a charge with ammonia at the temperature necessary. This was our first adverse blow.

In our extremity we heard from an engineer of a certain vessel in London that might be adapted to this high pressure and temperature, and we lost several weeks in adapting this, to find it also insufficient.

About this time I heard that one of the big dye firms had a vessel that might do such work, and I went at once to see if they could extend us temporary accommodation. I mention the incident because of its effect in other ways. The gentleman whom I saw seemed astonished at my visit and my request. What were we up to? This was a chemical operation, and we were only weavers, or some such remarks rather in disparagement of people like ourselves trying to make dyes, especially dyes requiring such processes. From my after-knowledge I learned that he had really no plant that could have helped us, so that his methods may have been by way of a screen, or bluff. But it had the effect of putting further fight into me, and " Begad," I said to my friend who was waiting outside, " I will let that man see yet whether weavers can make dyes." The next time we met was some four years later, after much water had flowed under the bridges. We had been asked to speak on the same platform at an important chemical meeting in London, and no one could have been more complimentary to our accomplishments than this man on that occasion.

But what about our autoclaving? The above incident was in early March. It was impossible to wait further months, for we were starving for colour. So we thought, why not try weldless steel tubing, and we learned that a length might be available at Cochran's boiler works at Annan. I can remember the very cold night on which we drove out to Annan on that quest, the

keenness and determination of each of us, and we brought back in our car the tubing, which event occurs in my notes, under date just three weeks after the rebuff recorded above, as follows:—

> "Saturday, March 27th, 1915.—Have had first satisfactory results silver salt into 2-amino-anthraquinone from improvised autoclave made out of Stewart and Lloyd M.S. Tubing 3ft. 8in. long by 10in. diameter. Charge 7 gallons silver salt and ammonia, gave us sufficient amino for 20 lbs. of colour. Immediately put two other vessels in hand, which should give us 60 lbs. per day, sufficient to dye 25 to 30 pieces cloth of a medium blue or green."

It was one of the red letter days, and though the colour was by no means "standard," it was the first real works Blue and Yellow Vats produced in this country, made, as you see, at the works in Carlisle, and from plant practically all local. It was, as I have said, the real beginning: for from that day we have never ceased getting our supplies from our own production. And it will give some idea of the growth from that small beginning when I tell you that of these two colours, or their variations, our plant has now a capacity of over 10 tons a week, or about 1 million lbs. a year.

By October of that year—1915—a thoroughly sound 8 cwt. autoclave, with stirring gear and everything complete, had come to the assistance of our little battery of tubing autoclaves. This was cast by Edgar Allen of Sheffield, and proved sound in every way. It was succeeded by one of a ton capacity, also made by the same firm, and later by some from Hadfield of Sheffield, and others, most of which are still running.

I have given you the history of these autoclaves in some detail because they are one of the chief keys in the manufacture of Vat dyes, and because they represented a problem in high pressure and high temperature reactions that was quite new to the chemical and engineering experience of this country, and that demanded a combined skill and knowledge of the highest order.

Fresh obstacles however had in the meantime been developing to an easy road to our dyes production. As I have told you, we began by getting our silver salt ready made, but it was soon apparent that this source would be no longer available. This meant that we had to tackle the whole problem of the manufacture of these long-process dyestuffs, not only from the silver salt forward to the finished dyestuffs, but from the crude coal-tar anthracene right through its stages to the silver salt. The chemists among you will realise something of what was involved. Commercial anthracene could be had of 40% purity only. This had to be purified up to 95% at two stages. It had then to be further sub-divided by sublimation with super-heated steam, which again had to be converted into crude anthraquinone and this developed up to a purity of 95% before it could be ultimately sulphonated with oleum into the desired silver salt.

Such was, roughly, the further road we had to travel for lack of a supply of ready-made silver salt. It was a road with obstacles enough to scare

amateurs in ordinary times, and when one thinks of the conditions then existing, one wonders how we ever started or ever got through. For it was just then that the nation was realising how long and tough the struggle of War might be. Every man and every human activity were claimed for the services of the War. And not only men, but materials. Can one forget the difficulty with which we could be spared a few pounds of lead or a few hundredweights of steel, or how we felt it almost criminal to beg, for any purely business purpose, the smallest extra supply of sulphuric acid, oleum or glycerine? I recall these facts now, not only to give you younger people some idea of the tense conditions of those times, but since criticism has sometimes been lodged against British dye-makers because they were not more advanced in their problems and production by 1918. Such criticism is apt to forget that not only were we all in person mainly engaged on other work essential to the War, but the very elements that go to the making of dyes were scarcely procurable.

By dint of many and varied efforts we got our new buildings and plant erected, on a small scale at first, and later in much bigger form, so that we were ultimately equipped for the making of these anthraquinone colours from the coal-tar to the intermediates and the finished dyestuff. Having had to extend our operations to this broader field, we naturally made investigations as to what other colours we should tackle to justify this comparatively large chemical plant. Our chemical reader at the Patents Library had been kept very busy, and had supplied us with the necessary data for our own group of Vat dyestuffs, and in the meantime we had gathered round us several young men of chemical training, so that research was now going ahead in our own laboratories.

Much of our attention just then was concentrated on colouring matters dependent on the initial production of benzanthrone and the working of this up to a high state of purity was one of the problems that engaged much of the attention of our chemists over a long period. The highly successful results of this work were of far-reaching importance in the later stages of our development, as pure benzanthrone became a very essential factor in the manufacture of new colours, to which I shall refer later.

Apart from these Vat colours for our cotton trade, one of the dyestuffs that lay nearest to our path, and one that we knew would be of great use to the trade of the country was what had been known as "Alizarine Sapphirole," one of the sulphonated-amino-anthraquinones, containing Hydroxyl groups. This came in for early investigation, and by March, 1916, we had produced it in small quantities, while by the summer of that year we were making it for use in our own carpet dyehouse, and had sold little lots quietly to our carpet friends, who prized it mightily. It is the fastest of the acid wool colours, and was looked upon as the key colour in blues for wool. Indeed, if it had been permitted to import one dyestuff during the War, and if there had been a census among wool dyers, the vote would have gone overwhelmingly in favour

of Alizarine Sapphirole. To give you some idea of the value of this colour, and the great loss felt by its absence, I think it worth while giving you a statement from important persons in the trade, which will speak for itself. On November 23rd, 1916, Mr. Sutcliffe Smith, a director of the Bradford Dyers Association, and for some years now chairman of the Colour Users Association, wrote an urgent letter to Mr., afterwards Sir Milton Sharp, chairman of that company, urging him to do all in his power to stimulate the production of Alizarine Sapphirole by some firm in this country, and in order to show its extreme importance, he proceeds :—

> " During the first six months of this year we dyed for this trade 55,872 pieces. The average value of these pieces amounts to £14 per piece, making a cash turnover value of £792,208 for the six months.
>
> " On account of our inability to obtain Sapphirole, our output has been so seriously curtailed that, had we been able to secure this dyeware, we could, with the same men working the same number of hours, have turned out 83,808 pieces as against 55,872, and the value of goods passing through our hands would have been increased to £1,173,312, or to sum up, goods to the extent of a further £762,208 would have been treated in a year. No effort should be spared to produce this dyestuff as I cannot over-estimate its importance to the whole of the textile trade, and its production will not only re-habilitate British reputation, but will be a distinct step in advance and a serious attempt to strike at Germany's supremacy."

So much for the importance and value of this dyestuff to one firm, and that was typical of the whole woollen and carpet trade over the country. This letter was written on November 23rd, 1916, and was quite unknown to me at the time. We had been making the colour, using it ourselves, and supplying it to a few friends in the trade, as you have been told, for six months previously.

But as I must explain at this point, we had given no publicity of any kind to our dye-making activities. We were using our production mostly for our own trade, and so had no occasion to advertise these activities or whatever achievements we might be said to have accomplished. On November 28th of that year, 1916, there appeared a very triumphant advertisement in the morning papers from a large Dye Company under the heading " A New British Dyestuff —Indanthrene Blue," claiming that whereas German chemists had prophesied that no British firm would produce this Vat dyestuff within ten years, they had now accomplished that feat. In spite of my native modesty, I thought it only fair to our chemists and to the situation generally to let it be known that this feat of the big Dye Company did not represent the high water-mark of British achievement—that we had been making that colour and others of the same series for over eighteen months, and that many thousand yards dyed by these colours had already gone from our works to all parts of the world.

This letter of mine to the public press had the effect of bringing many enquiries from users, and among them one from the Bradford Dyers Association, who had learned that, besides Vat Colours, we were actually producing Alizarine

Sapphirole after which, as I have shown, they were so much hungering. It led to an immediate meeting between the directors of that company and myself and much useful collaboration afterwards. They had delivery of the Sapphirole —which we called " Solway Blue "—within a few weeks of our meeting, as well as of some of the Vat colours, and they have not ceased to get them in increasing quantities and varieties from that day to this. I want here, if I may, to put on record the great spur given to our efforts by the directors of that company, especially by their late chairman, Sir Milton Sharp, who both in private and public was so frankly generous in his appreciation of our endeavours. It was a great help and stimulus at a difficult time. And these things are not forgotten.

As I have said, that little bit of almost compulsory publicity brought us enquiries for colours from users all over the country, and we had to multiply the production as quickly as the conditions would allow. Of that most indispensible blue colour we were making by 1918 half the total pre-war imports, and by 1919, 50% more than the total pre-war imports; while to-day our production is several times the total pre-war imports, and the colour is also made now by other firms in this country.

This was, perhaps, one of the chief services we rendered to the general trade of the country in the War, and I believe users were agreeably astonished at the moderation of our price. I sometimes think now that had they been dealing with a Scotsman from Aberdeen instead of one from Ayrshire, they might have been asked to pay a somewhat different figure for a commodity so invaluable at the time—one of those little facts of which one likes to remind the users in our controversies to-day!

With these outside orders rushing in—we had one contract for 100 tons of colour—our dye-making section was becoming a place of considerable activity, and it was at this time that we decided to detach it from our textile business. It was first run under the name of " Solway Dyes Company," still owned and operated entirely by ourselves. I was averse then to inviting outside capital for a business that had so many risks, and even now might only be temporary.

But, as you can realise, all that long research by chemists, and the erection of buildings and plant to cope with large production, had made us dip fairly deeply into our coffers, and we were a comparatively small private concern. This possibility occurred to me. Why should we not try to interest some American makers in the results of our hard earned experience? The money would be very useful. Several firms over there had been making dyes, but none so far had attempted such a colour as Alizarine Sapphirole, and very little had been done on Vat dyes. These anthraquinone colours were bound to have a large demand in the American market. We set out to interest some one in the making of them with a view to helping our finance in this obvious and natural way. It was still War-time, and negotiations were difficult, but during

1918 a plant was erected in America for the manufacture of a ton a week of our Solway Blue (Alizarine Sapphirole), from plans and processes prepared by us, and two of our chemists from little Carlisle went out to set that plant agoing in America. And it is working regularly till this day.

In the next year, 1919, I went to America with a view to extending this idea. It led to an arrangement between ourselves and a large chemical company in America that has been of extreme importance and mutual value. In works over there were put up duplicates of what we were doing here. That arrangement has continued unbroken, and to-day they are supplying dyers and manufacturers of America with a large proportion of their very extensive requirements of Vat colours. There is a complete interchange of information and experience. This has brought advantages to both, and the association has been one of ever-increasing co-operation and cordiality.

But my visit to America, which lasted some three months, had another result which turned out to be of far-reaching importance to our enterprise, and which I must relate as briefly as I can. By the end of 1919, it was evident that our dyes venture was to be no passing phase and we had already taken an important step towards its establishment on a permanent basis. This step, I should like to record, was taken shortly after, and as a direct result of a speech by the President of the Board of Trade, Sir Albert Stanley, now Lord Ashfield. In this speech he had explained the Government policy, whereby there would be a certain regulation in the importation of dyestuffs for ten years after the War. Certain grants-in-aid would be given towards research, and also towards construction of plant for colours not yet made in sufficient quantities in this country.

Up to this date all our dyes activities had been carried on in buildings adapted or erected within our textile area, and these were proving quite inadequate to cope with the demands now being made upon us. We decided that future developments should be on fresh fields—near the sea for effluent, and where we could have ample supply of suitable water and good transport facilities. Ultimately Grangemouth was chosen as fulfilling these conditions. There we got a site with an option on eighty acres, and we then became Scottish Dyes Limited. At this juncture we invited the financial co-operation of one outside party, a gentleman already interested in chemicals and thoroughly conversant with all the risks that might attach to a new dye industry in this country. At a later stage a few of the larger colour users and suppliers of chemicals also became financially interested in our undertaking. The construction of this new place was going ahead while I was in America at the end of 1919 and the beginning of 1920. We were laying plans for the manufacture of anthra-quinone dyestuffs on a big scale.

But one factor had often worried us, and now became more acute in view of these extensions, namely, the supply of anthracene, which was the basis of all our operations. This hydro-carbon forms a very small fraction of the

coal-tar, and very few distillers would trouble to extract it, with the result that any industry dependent on anthracene was at the mercy of a few people. Even in our short experience we had had difficulties about supplies, while on several occasions we had had to pay exorbitant prices. It was obvious that if another source could be found for our necessary raw material, we should be on a much sounder footing for large operations.

It came to our knowledge that a new process had recently been discovered in America for the production of Phthalic Anhydride from naphthalene by an air oxidation process. We had been aware that the production of anthraquinone from Phthalic Anhydride was an alternative source of supply for our starting material, but the cost of Phthalic Anhydride by any previous process had seemed to shut the door to this avenue. It struck us, however, that by this new air process the cost must be so low that it might bring the process within the field of possibility. So it was one of my other missions on this visit to America to investigate this process, and to see whether the conditions were such that it might solve for us this outstanding trouble of anthracene supply. For it was obvious that if we could switch over from anthracene as our basic material to naphthalene, we should be on absolutely safe ground. Not only is naphthalene much lower in price, but the supply is practically unlimited, representing as it does a fraction in the coal-tar some 15 to 20 times the volume of anthracene. And it is isolated by practically every tar distiller. It was worth any effort to enable us to realise a condition of this kind. But would it be possible for us to acquire the process?

I must really refrain from entering on the story of that deal in America for the British rights of this new process for the manufacture of phthalic anhydride. If I ever write a romance, I think I shall call it by that sweet name! Suffice it to say that when I recrossed the Atlantic, it was with this "ugly duckling" as part of my baggage. For when I presented it to our boys in the home yard and told them the cost, their congratulations, or their words of welcome were, I am afraid, not too effusive!

Other things were happening in the dye trade just then that made the advent of expensive "ugly ducklings" not too auspicious. I mentioned a short time ago that we had launched on our bigger scheme of dye-making on the basis of the Government promise to restrict the import of dyes for ten years. This declaration of prohibition was given under an Act of 1876, whereby the King had power to prohibit the importation of arms, ammunition, gunpowder, or any other goods. The Government relied on the words "any other goods" to enable them to exclude chemicals and dyestuffs. In August, 1919, this restriction was contested by a firm who wished to import certain chemicals, and the court, by what was called the Sankey judgment, held that the words "any other goods" in that connection did not refer to chemicals or dyes, and that the Government had no power to prohibit the importation of these materials. As a result, there followed a full year in which users were free to import all the

dyestuffs they wanted. At the same time the Government saw fit to take as part of their reparation payments from Germany huge quantities of dyestuffs. So that during the year 1920 and into 1921 it is claimed that dyestuffs to the value of something like £7,000,000 were arranged for import to this country. At the same time the Indian market, which had formerly been considered closed to German dyes, was made free to that country, with the result that large contracts which had been given to dye-makers in this country, ourselves included, were immediately repudiated. On the heels of this came what was known as the slump in trade, when demands for goods of all kinds seemed to stop in a single night. That combination of events made very melancholy times for the dye-makers here who had erected or were just erecting plants to supply the total needs of the country and the Empire. It was a cold draught indeed, two years of a bitterer wind than one ever wants to know again.

But this hiatus, like adversity, was not without its uses. If our chemists were not needed for production, they could research ; they could improve and revise many existing processes, and they could venture out on new fields. So in these two adverse years, though we drew in our horns in many ways, we did not dispense with the services of a single chemist. Indeed, it was a time of precious research, which bore much good fruit, as you will see.

Among other things, it gave time for our chemists to make better acquaintance with the ways of the little "ugly duckling" which I had thrown among them so unexpectedly. Like others, it had passed through a hazardous time enough. It seemed to contract certain foreign troubles as well as some home maladies, but at length it developed some quite unexpected feathers, and was soon to become the pet bird of the flock. Our chemists discovered that these beautiful long white crystals of phthalic anhydride were capable of flights which they had never anticipated. We had certainly expected them to bring us anthraquinone from naphthalene that would make us at least independent of the more limited anthracene, and perhaps at a lower price. This was soon accomplished, but our chemists found that not only could they get an anthraquinone of the requisite purity much more easily, but that it offered a ready avenue to new and important derivatives of anthraquinone without the necessity of passing through the anthraquinone stage—the white wings of the phthalic made possible the flight, free of that island altogether.

As you chemists may know, a simple transformation involving phthalic anhydride consists of the production of benzoyl-benzoic acid from it by condensation with benzene. Benzoyl-benzoic acid is simply anthraquinone with an extra molecule of water added to it, thereby leaving one of the links open between the two outside rings of the molecule. When this ring is closed by extracting the water with an agent such as sulphuric acid, anthraquinone is formed. But in most of our operations for which anthraquinone is needed it is not necessary to isolate the anthraquinone. The benzoyl-benzoic

acid acts as a raw material, and can be directly converted into any intermediate for which anthraquinone was formerly used. The application of this discovery by our chemists as a new use of phthalic anhydride is of far-reaching importance in the realm of anthraquinone dye-making, and is the subject of several Scottish Dyes patents. It now permeates practically all branches of our many processes, and has enabled these anthraquinone derivatives to be made with a degree of purity and at a price that was unattainable from the old process from anthracene. Indeed it may be looked upon as a revolution in that section of dye-making.

One outstanding result of this process, and one that could never have been attained otherwise, is that it has enabled Scottish Dyes to make and put on the market a Vat Blue colouring matter which is without question the fastest blue on the market. What is more, it is the fastest blue that has been made anywhere at any time, ancient or modern—a very big claim to make! It has only been on the market some three years, and it will give you some idea of its recognition by the users of dyes if I tell you that of this one blue we now make more tons a year than the total imports of all Vat colours put together before the War. That I look upon as one of the greatest achievements of Dr. Thomas and his staff of research chemists, done largely during the slackness created by the "dump" and "slump" period—but, as I modestly remind them, something they could never have done but for the advent of my not-too-welcome "ugly duckling," the phthalic anhydride.

Our "duckling" is only at the beginning of its hatching. The latest product from it is Alizarine Red (Turkey Red) by a new process from para-chlor-benzoyl-benzoic acid, a derivative of phthalic anhydride. This red is the purest of its type that has yet been made, and a plant for its production of about 20 tons a week is now in operation. Another product about to be marketed is benzoic acid of a very high purity. Phthalic anhydride is also beginning to be used in this country for the manufacture of condensation resins for electrical work, and its uses in other directions keep ever on the increase. We are now making many tons a week of this beautiful crystal phthalic anhydride for our own use and for general sale, and the plant is about to be doubled.

I must now refer to another product whose growth was specially nurtured during that adverse year till it ripened and fell into our harvest basket to brighten an otherwise gloomy autumn. I refer to Caledon Jade Green, a product by which Scottish Dyes has become better known perhaps than by anything else we have done. But that was not the result of a day or a year. As users before the War, we always felt much the want of a green of pure quality for our *Sundour* goods. Early in the days of our dye-making, and as soon as we had research chemists of our own, I determined that we should have a hunt for such a green. It was one of the obvious blanks of the Vat palette, for we had pure blue, yellow, purple and red, and I somehow felt that somewhere

amid that maze of compounds a green, such as was wanted, was lying buried. It was a vast field that had to be explored, and we knew it must be a long and tedious road. For over four years one or more of our chief chemists and assistants were engaged mainly on this quest. Long periods there were of blank sterility, but ever and again little crops of verdure would give indications of something coming, only to be left behind again and the hunt restarted. At last, on the 11th September, 1920, the chemists came triumphantly to me with the first few grammes of the beautiful green colour that has not changed since, and that has indeed made history for itself and for Scottish Dyes. It was somewhat bluer in tone than one had hoped for, but a beautiful Jade, and it was there and then christened, and has ever since been known as "Caledon Jade Green."

The provisional specification was filed on 27th November, 1920; the complete patent was granted on 29th May, 1922, the British number being 181,304, and the Jade Green Patents over the world number 22 in all. Briefly, it is produced by oxidising dibenzanthrone to the hydroxy-derivative by means of manganese dioxide and sulphuric acid. This is then methylated with dimethyl sulphate to give the Caledon Jade Green. Plant for its manufacture was immediately erected both here and in America, and in a short time it had made a place for itself second to none in the Vat range. But why was it so important a colour that it should make such an immediate impression in the dye trade? Because not only was it the only pure green of the anthraquinone Vats, but it was found to be the fastest all-round colour of the whole Vat series.

We learned, shortly after it was on the market, that the German dye-makers had adopted it in their laboratories as their new standard for all-round fastness —a tremendous honour to a new and foreign-made colour. Perhaps no achievement up to that time had so convinced the Germans that British dye-makers were now a factor to be reckoned with.

But this colour was patented in Germany, and they could not produce it. What would happen we sometimes wondered; for we knew that they could not ignore the advent of a colour so outstanding as that Jade Green. In due time diplomatic soundings came, and in their wake developments which may almost be called historic. For these negotiations led to our being visited in the North by three of the chiefs of the Badische Company of Ludwigshafen to discuss terms for the production by them in Germany of our Caledon Jade Green.

That was on the 3rd July, 1925. I am frank in saying that we took the visit as a great compliment. It was the first time that I know of in at least half a century that representatives of a German company had come to Britain on such an errand. They were not easy negotiators, but we had a most friendly meeting, and at last the conditions were adjusted to the satisfaction of all parties. And now comes the sequel to the incident which I gave you

in the first part of my story. You must remember that these three gentlemen were from the same company as I had visited in the autumn of 1913. When everything had been properly adjusted and documents signed, and we were indulging in more easy talk, I recalled to my friends in a bantering way the occurrence I have already mentioned to you, and Dr. Bohn's jocular suggestion of placing my bust in the vacant niche in their Hall of Honour. "What about that bust now?" I chaffed them. "Surely the Jade Green deserves the honour." Their spokesman looked at me somewhat seriously. "Bust!" said he, "do you know, Mr. Morton, when we read your specification for that Jade Green we were so wild at having failed to discover it ourselves that we could have 'kilt' you." They were most complimentary all the same, and in order to be quite fair on our side, I want to relate here that the collaboration with that company over this colour led to a suggestion on their part for an improvement in one of the stages of manufacture that has enabled us to produce it at considerably less cost, and has given the colour a much wider field of usefulness. In this both parties have benefited. As to the importance of the colour, I think it will not be questioned if I make the statement that it is the most outstanding discovery in the dye trade since the introduction of the first Vat dye-stuffs a quarter of a century ago. For this Jade Green is the fastest green made anywhere to-day. It is perhaps the fastest colour made anywhere. It has been on the market only a few years, and though I have not quite full data to verify it, I am going to venture the statement that of this Jade Green there is a bigger tonnage being made in the present year, between here, America and Germany, than the total tonnage of all the Vat colours put together in the year before the War. And the research and discovery of that epoch-making colour was all done in the little laboratories at Carlisle.

I feel that you must have had more than enough of the details of a dye works. Before closing the catalogue, however, I just want to refer to one other phase because I know it is one that is sure to loom large in the future. For the most part my remarks have made reference to Vat colours, and in one's mind one always considers them in their relation or application to cotton or vegetable fibres only. This is owing to the fact that, except in a few cases, the amount of caustic soda necessary for the dyeing of these Vats makes them inapplicable to wool or natural silk, as the caustic destroys or tenders the fibres to a very great extent.

It has always been a dream of the manufacturer to get the use of these fast colours for wool and natural silk, and the trade has been waiting in expectancy for its realisation ever since the introduction of the Vat colours. In our textile laboratories we have spent much labour and research over this problem for several years. It was obvious that if these Vat dyestuffs could be got soluble in water, and could thereby be applied direct to the fibre without vatting in an alkaline bath, the desired end would be attained. This is a research which I caused to be instituted in our textile dye

laboratories some years ago. In August, 1924, we were at last successful in finding a suitable process for rendering these anthraquinone Vat dyestuffs soluble in water. This process was at once handed over to Scottish Dyes to develop on a manufacturing basis. In January, 1925, we issued from our works at Grangemouth Caledon Jade Green in a soluble form as the first of what we called the "Soledon Dyestuffs." This was the first anthraquinone Vat dyestuff to be put on the market by any firm in a soluble form. A few months previously a Swiss firm had put indigo on the market in a soluble form under the name of Indigosol, but it was by a different process of manufacture. They have confined their commercial activities so far, with perhaps one exception, to the production of soluble Indigoids or closely related compounds.

This process of converting vat dyestuffs into their soluble sulphuric acid ester derivatives is a development that is now going on at Scottish Dyes in a vigorous way, and that has very great potentialities. It is a problem, so far as anthra-quinone Vats are concerned, that has been lying to be solved for many years. I am sure that in times to come it will be one of the main claims to distinction attaching to the chemists of this country in this age—that the long-looked-for solution has come from the chemists of these two British concerns—Morton Sundour Fabrics and Scottish Dyes. It is difficult to prophecy, but I do not think I shall be far from the mark if I hazard the statement that in ten years' time all the so-called Fast Vat colours will be used mainly in this soluble form on cotton and other vegetable fibres as well as on wool and natural silk. I shall be much surprised also if they are not all, or nearly all, made by the new and simple process developed and fully patented in all countries by our two companies.

I want to record here the splendid support given to all this work from its very inception by the chemists and engineers of the concern. They began as a very small band indeed, but they were loyal to the venture, and those who were there at the first, some fourteen years ago, are there to-day. We have not had cause to dispense with the services of a single chemist through all those years, nor has one left us, though several tempting offers have come their way. It may be interesting to relate that we have not at any time engaged, nor have we now in our employ, a single chemist who had previous experience in dye-making. They have been a band of ever-increasing strength, working in the friendliest co-operation and loyalty under Dr. Thomas, their head. We have had to mourn the loss through death of two young chemists, one of them, A. H. Davies, a scientist of great ability and promise. We have been lucky during most of these years in the official co-operation of Sir William Pope, of Cambridge University, whom we look upon as the father of our team, while for an even longer period we have had the countenance and constant interest and encouragement of Professor Armstrong, our chairman to-night, whom we may call the grandfather of the family. His visits, of a purely friendly

interest, in the early days were a source of great help and inspiration, which I should wish to put on record.

In these more recent days we have all been adopted and have become part of a much larger family, for we were considered worthy of being included in the group which now forms the great Imperial Chemical Industries. While we continue our own activities and carry on along the old lines, we bask in the beneficence of the big chemical sun, and I see no reason why under it we should not produce fruits more precious and plentiful than ever in the past. For research is made more possible, and, what is most important, the fruits of research are capable of immediate realisation by reason of that great Bank on the River Thames.

In closing the first part of my story I told you how the threads of our web had suddenly been snapped, and how the second part would tell of the gathering up of those broken ends, their piecing together and the starting of our new web. The work involved in all this process has kept us so busy and so absorbed that one has scarcely had time to look at this new web, now that it is in full swing again. Had it not been for the kindly insistence of friends, I question if one would ever have taken the leisure to sit down and look at it all in the way that the preparation of this paper has entailed. When one compares the new with the old, I am sure you will agree that we have now a web whose threads have in them a strength and an interest incomparably greater than anything they ever had before. Every colour we use now speaks and lives and is full of the intensest new meaning. For instead of colour being only a blank page to us, it is now filled with a story of supreme interest, of long, arduous research, of high pressures and high temperatures, things attempted and done, telling also of things yet to do that are full of hope and adventure, which, after all, is real life.

I only hope that in what I have said I may not have given the feeling of too much self-satisfaction in our accomplishments. There has been in certain quarters some adverse criticism of the slow progress being made by dye-makers in this country, especially, as it happens, in relation to Vat dyes; and some of the statements I have made I have thought perhaps overdue in reply to such criticism. But I can assure you that we are only too aware of the minor part we play in the great field of chemistry and even of dye-making. What we have learned and what we have done have only taught us how marvellous are the wonders of the new world to which we have been introduced, and of which we have touched only the margin. And among the things it has enabled us to appreciate the more is the gigantic work represented by the growth of synthetic dye-making in Germany in the past fifty years. Only ignorance would try to belittle what has been accomplished by the chemists of that country during these past decades. If you young chemists want to be enthused and to get inspiration for your work, read the story of the inception and development of synthetic indigo as told by Dr. Brunck in his historic speech

at the opening of Hoffman House, in Berlin, in 1900. It tells a story of initiative, skill, and indomitable perseverance against obstacles, for a period of eighteen years, that are worthy of a great epic. No one must ever deny them the honour due to that great work and others like it. But we must never forget, and the Germans always graciously acknowledge it, that they got the scent of all this trail from the young man Perkin of this country, who kept it valiantly for many years. We lost that trail some fifty years ago, but in the upheavals of these recent times our senses have again been quickened, and we have, I hope, caught up that trail again. This is all I should want to claim from the recounting of such incidents as I have given you and they could be multiplied from other works. We are again in the field, and it is for you young ones to keep keen of scent. See that you prove good sportsmen and that the trail be never again lost.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said there was no one, probably, to whom Mr. Morton's lecture could have the significance that it had to himself. The man from whom all these blessings flow, Hofmann, had been his first master in chemistry. It was Hofmann who, in 1843, had made the discovery that the reduction product of the nitrobenzene prepared from Faraday's benzene (1825) by Mitscherlich in 1834, made by Zinin in 1841, was to be identified with Fritsche's aniline, also first obtained in 1841, by distilling Indigo (Portuguese anil) with potash. Hofmann had exploited aniline with a marvellous enthusiasm, skill and thoroughness. He (the Chairman) had told the story at length in his contribution to the Hofmann Memorial Lecture before the Chemical Society. Hofmann, it should be noted, had set Perkin to work on anthracene.

In 1869 he (the Chairman) had worked in the Leipzig laboratory alongside Graebe, then a Privat-docent. In collaboration with Liebermann, Graebe had then but recently established the relationship of alizarin with anthraquinone. He recollected Graebe coming to England to negotiate with Perkin over the Alizarin patent. On his return to England in 1870, Perkin had been one of the chemists with whom he was at once intimate and he had had the privilege of becoming his colleague, as junior Secretary of the Chemical Society, in 1875. Perkin had laid the foundation stone of the dye-stuff industry by his discovery in 1856 of Mauve, which he began to manufacture at Greenford Green in 1857. He (the Chairman) had known all the chief actors in the great colour drama; a more brilliant intellectual band could not be. Beginning work in the year in which, through Kekulé's inspired genius, benzene became a living soul, he could overlook an astounding field of discovery. The romance of the story was beyond words—one almost transcending imagination. Moreover, it was all absolute solid fact registered in terms of most wonderful colour, capped by Jade Green. If Mr. Morton had been true to his colours, he would have appeared in Jade Green that night, instead of in a dull black suit. The world strutted in colour but had no understanding of the work. Chemists were a small class apart, content with the content of true achievement, which was ever the best reward, above and apart from any praise or payment. Mr. Morton had a rich reward, he felt sure, in the knowledge of his brilliant success, in addition to the material ways in which the world was showing approval of his work. No man had better reason to be proud of his success; he had won it because

he had been qualified for the work and with calculated means. " Dour," however it was pronounced,* was a word associated with the Scot. People were told it meant " stubborn," or " hard to move." In Mr. Morton's case it had meant " hard at the attack." Throughout his career he had gone steadily forward, always improving. His success in the chemical field recalled that of Perkin. Perkin was always vaunted as the discoverer of the first artificial dye-stuff, Mauve. The discovery was sheer accident ; there was nothing in it. Perkin's greatness lay in recognising his opportunity and entering upon the astounding task of founding an industry when a youth of only nineteen ; his greatness lay still more in succeeding. Raw materials had had to be found. Every operation had been new—at least on the scale on which he had been called to work. Special plant had had to be designed and constructed for each process. There must have been something of the prophet in Perkin in those early days to have led his father to put his means into the boy's enterprise and his brother to become his partner and look after the business side. He (the Chairman) would show the audience the pictures of father and sons—a wonderful triumvirate. Perkin had led the world into fields of loveliness undreamt of before his time but he had made only a modest commercial success of his beautiful foundling and its far more stalwart, light-fast, pigmentary relatives. He was too narrowly educated, too inexperienced in the world; he had no helpers; he lacked the vision to develop and expand his business to the extent necessary to meet the growing competition. He had stolen a march on Graebe but German commercial-scientific solidarity was eventually too much for him. His retirement from the field had also higher reasons. He was no mere maker of goods. He was an artist in many ways—a musician ; he could wield the brush ; he was a bit of a Lucullus in early days—the tendency was far more marked in his jovial and more worldly brother ; he was only led by his piety to become a vegetarian and abstainer in later life ; he had wonderful fingers, which he itched to put to further creative use. Above all, the holy fire of original genius burnt within him, so he withdrew to his laboratory and became the physical chemist of high degree, an example for all time. There was more than something of the prophet in Mr. Morton. He looked the part—one could imagine him preaching a gospel in a Scotch kirk. He had magic personality, the power of attracting disciples who remained not merely his fellow workers but one with himself in a passionate determination to carry their mission to success. His had been a more difficult task than Perkin's. He had been called on to do more difficult things at a time when everything was difficult. Still, he had an organisation at his command and faithful assistants. He, too, was full of wit. That he had business ability was clear ; he also had complete technical command of the textile and dyeing industry. He would not say that Mr. Morton understood dye-stuff making technically—he did not suppose he could answer a question in an examination—but he was in complete sympathy with its problems, its methods and its difficulties. Obviously, too, he had the research spirit within him—his study of fading was proof. In addition, he was a man of high artistic feeling and culture. He had scoured the world in search of colour patterns. If one went to his museum in Carlisle one would see a wonderful collection. He would now pay Mr. Morton his highest compliment. Nothing had struck him (the Chairman) more as a youth, when a student in Leipzig, than the cultured intelligence (largely derived from the University) of the German business man. He had had the entry to several houses there. He had met with nothing of the kind on his return to England and had rarely met with it here in the interval,

*To me it is "dower"—having always at the back of my head the German verb dauern, to last, which must be at its root. I prefer to render it as "lasting, steadfast, trustworthy."

except in houses like that of the late Dr. Mond. Dr. Mond had made his industry a great success. German industry had always been in the hands of technically qualified directorates. We had too often courted aristocratic failure. The Dyestuff industry had been a failure in this country from the time of Perkin up to the war, because it was never in the hands of business men of sufficient intellectual calibre, culture and sympathy. We should hold our fair share of the industry only so long as such men had charge of its ways and means. Chemists might come, chemists might go—they were indispensable—but a wide charity must also be operative to make an industry succeed.

He had felt it a great privilege during the past dozen years to have had Mr. Morton as a friend ; to him he had been an intensely interesting study. To chemists he brought a lesson of the greatest consequence. They might have played their part at any time. Some had long held that English failure to maintain an organic chemical industry had been due to lack of leadership on the commercial side—to lack of intelligence in our business men. Mr. Morton had proved that to demonstration but in so doing he had given a warning. He had developed only a section of the industry. The larger section had been encouraged into a passing prosperity by entirely artificial means. No mere combine would sustain it. Complete and undivided technical efficiency of management alone would secure its continued success. For chemists it was an anxious time: they were accustomed to weigh and measure and were not without ability to read even a commercial barometer.

Mr. H. T. Tizard, C.B., F.R.S. (Permanent Secretary, Department of Scientific and Industrial Research) said he need hardly tell the Chairman, at any rate, that personally he knew nothing whatever about the subject. He had attended the meeting because of his general interest in the matter, and also because the very high reputation of the lecturer had even reached one, in the person of himself, who knew very little about organic chemistry. All he could say, after having listened to the lecture, was that not one minute of one's time had been wasted. Mr. Morton had given a magnificent record of one of the greatest achievements of modern times. He could not help feeling that if the country had a few more like him the depression which was so apparent today would not be there. He had happened to note one or two remarks of Mr. Morton as he had been delivering his lecture, and he did not think he could do better than repeat them. The first, which had a bearing on the recent remarks of H.R.H. the Prince of Wales, was "Our firm had behind it a long-standing reputation for reliable goods. . . . It was at this time I made an exhaustive tour personally among our customers." The next quotation he desired to make—and one which he would like to see written up everywhere—was, "I was adverse then to inviting outside capital for a kind of business that had so many risks, and which even now might only be temporary." Finally, and the greatest quotation of all, and one which earned everyone's respect and admiration, because it showed the lecturer's courage and long-sightedness: "If our chemists were not needed for production they could research, so in these two adverse years, though we drew in our horns in many ways, we did not dispense with the services of a single chemist." He thought he need say no more, because nothing he could say could really enhance Mr. Morton's reputation. He could only conclude by saying how glad all those who had the interests of the country at heart must be that Mr. Morton had not suffered through his courage, and through putting into his business all that he had to put in.

Mr. G. P. Baker, who is connected with the dye industry as applied to textile printing, said he had attended that night to pay his tribute of appreciation

to Mr. Morton, whom he had known for very many years, and whom, after having listened to the paper, he admired more than ever. It was a wonderful story which Mr. Morton had told. What an incentive it was to the young chemists of the present generation. His own days of energy had departed, but he desired to emphasise what Mr. Morton had said—that before every young man there must be an ideal—something towards which he must aim ; an ideal such as Mr. Morton had had after seeing his goods in a window damaged through no fault of his own. He thought that the niche in the wall of that hall of honour which had been mentioned was still reserved for James Morton, and that his bust would be found there some day. Britons were proud of Mr. Morton ; he had forged the most important link in the chain of the dye industry of this country since Perkin's day. That in itself was a great achievement.

Mr. T. C. Dugdale remarked that it was well known generally that the pioneer work which had been done by Sundour had been eminently valuable all over the textile trade. Scottish dyes had saved the country during and after the war. From that point of view, had it not been for the lecturer, probably the country would have found itself very badly wrecked as far as fast colour was concerned, because it had been impossible to get any sound dyes from Germany, the Government having seen fit at one time to debar them entirely. It had been the fact that Scottish dyes had been originated by Mr. Morton which had saved the situation for all textile people. For that reason alone every chemist and every artist who had any connection at all with the textile trade should be extremely grateful to Mr. Morton. The paper contained a history of the subject which it was well worth while everyone digesting at leisure.

Mr. J. Guilfoyle Williams said he was engaged in a large departmental store in London and had been very interested in that part of the lecture dealing with fast dyes. Perhaps a few remarks from the consumer's point of view might not be out of place. He found that the term "guaranteed fast dye" was used sometimes in a very loose sense either by the manufacturer, the buyer, or the wholesaler of the cloth. At least 15 per cent. of the samples which were submitted to him by the buyers of the organisation with which he was concerned were not fast dyes ; a number of them were ordinary cotton dyes, and some of them were very fugitive. He thought there was need for education of the buyers and of the public concerning fast dyes. For instance, he had recently been told by a buyer that he did not really see much point in the Vat dyes, as he had been told on excellent authority (a traveller in fabrics) that Vat dyes were simply ordinary dyed fabrics which had been washed until no more colour came out.

The Chairman, interrupting, said he did not think the meeting could enter into a general discussion of fast dyeing that evening.

Mr. Henry G. Dowling said Mr. Morton had stated that those concerned in the matter must study the science of selling. That was an echo of what the Prince of Wales had said that week. Mr. Morton certainly seemed to be a prophet with a message. The story of the adoption of the trade mark had been most interesting. It showed the value of a good trade mark and a good slogan in business. He himself also desired to emphasise the importance of personal contact with customers. If principals of businesses would get into direct contact with some of their customers and endeavour to get to know the requirements of their customers it would be better for trade generally. Another point in the lecture which had interested him

was that which referred to the value of science schools. He was certain that was a point which appealed to the Royal Society of Arts—which was a Society for the promotion of arts and commerce. Another very great point was the value of idealism in business. Mr. Morton had had an ideal, and to a young man like himself that had appealed to him. Another matter from the political point of view was that of the value of safeguarding. He was not conversant with the chemical formulæ and processes involved, but it was interesting to him to know that many of the names which were frequently used when discussing dye colours owed their origin to Mr. Morton's work. He also could not help feeling that Mr. Morton had been somewhat inspired by that great man, William Morris, who, whatever he attempted, mastered, finding pleasurable delight in the hardest of work. Morris insisted on his own complete absorption in his work. He also insisted that the materials which he employed should be sound and durable, and, he believed, also made his own dyes. As a young man he was proud to have listened to the lecture. Mr. Morton had referred to "the beneficent trust." It was a surprise to him that under a trust or combine individualism was still possible.

Mr. M. Atkinson Adam said he had listened with very great interest to the lecture. Nothing but Mr. Morton's indomitable driving energy could have carried him through his initial difficulties. He had had the privilege of visiting Mr. Morton's works in Carlisle in 1915, and to have seen the beginning of the development of Mr. Morton's dye production. At that time he had been very much afraid for the successful accomplishment of the effort on which Mr. Morton had started, as it seemed so extraordinarily difficult. He had watched Mr. Morton's efforts throughout the years, and had been more and more struck with his vision, and his idealism, and with the powerful driving energy by which he secured the accomplishment of his aims in face of all obstacles.

Dr. Thomas Jones said the last speaker had referred to the fact that he had visited the Carlisle works in 1915, but he himself had had the prouder privilege of having visited the tomato house at Penrith, and he remembered quite distinctly the exposed cards of yarn. The "Flodden Field" was very vivid before his mind's eye now. It was quite true that Mr. Morton was a man of remarkable driving energy and of vision, and of all the other qualities with which he had been credited that night, but nothing had been said about Mrs. Morton or the family, and what they had had to endure, and he was almost inclined to ask the meeting to pass a vote of sympathy with Mrs. Morton and the family at having had to live with Mr. Morton—or, rather, to have had to live without him! His first sight of Mr. Morton had been in a small room in which the Forty Club met in Glasgow—he supposed about thirty years ago—and Mr. Morton had on that occasion been reading a paper on William Morris. That might interest one of the previous speakers who had referred to William Morris. Might he make one appeal to the Chairman? Would he ask the chemist who had been referred to several times during the lecture (Dr. Thomas) to stand up so that everybody might see him.

(Dr. Thomas stood in his place and was given a hearty reception by the meeting.)

Mr. W. K. Beaumont said, as one who was particularly dealing with the selling of the lecturer's goods, he would like to ask whether the new process of producing the dyes would make Sundour dyes absolutely fadeless. He had had experience with guaranteed fabrics, and some of them had been returned to him as having faded. There were very few such occasions he would admit, but he would like

to know whether in the future the dye industry would produce absolutely guaranteed fadeless dyes, and whether that fadeless guarantee would extend for more than, say, two years, or if there was any limit to the lasting of Sundour dyes.

Dr. Arthur Hopwood said the Chairman's remarks with reference to Professor Perkin were quite exemplified in Mr. Morton also. Mr. Morton's father had been very similar indeed to Professor Perkin's father—a man of outstanding ability and a pioneer in many directions. The great fact which he had noticed about Mr. Morton was that he never allowed any difficulty, however big, to stand in his way. As a textile man he had been confronted with the difficulties of getting dyes during the War, and had reluctantly to switch over to the work of a chemist to make dyes himself by most complicated processes, and yet he had carried these out in a most remarkable manner. Another point not so well known was that Mr. Morton sent his workers to a School of Chemistry in Carlisle to receive their education there, and also paid their fees and wages whilst they attended the classes. Three other textile firms did the same in Carlisle, which was a very fine example to the rest of the manufacturers in the country.

The Chairman, in moving a vote of thanks to the lecturer, said the lecture would in a measure—but only in a measure—help the world to understand what had been done. The story could not be told in a way to bring it fully home. It was apparently only at intervals that the people of the world got such men of genius as Mr. Morton coming up amongst them. To those present it must have been a great pleasure to see a genius for once in their lives.

The vote of thanks was carried unanimously.

The Lecturer, in acknowledging the vote, said the remarks which had been made about him had been much too flattering. One speaker had asked a very pointed question which he had better answer—about the fastness of the dyes. As he had said in the paper, in all his firm's efforts to get fast colours they had aimed at what was called practically fast dyes. The audience would have gathered that the effort he had made had been in the nature of a protest against something which had been entirely wrong. There had been something almost immoral in the things which had been done, and his effort to get a new standard of colour had been in the nature of a protest. Ever since then his firm had been aiming step by step to get to a still higher point. They had got some colours that really might be called absolutely fast if they were properly dyed and properly handled; but, as was well known, in the course of about a half a dozen processes where the human factor came in there was an opportunity of something going wrong. In all guaranteed goods one had to take account of the human factor which might have made a slip. In the early days of Sundour the firm had laid aside a sum out of profits against complaints which might come in; but it had been found that the number of complaints had been so infinitesimal that that reserve had been abandoned altogether. They had found that by using the very best colours known, and dyeing them in the best possible way, the number of complaints had been really infinitesimal. He was certain that if dyers took the utmost advantage of what was now available, the trade would never have complaints on that score. It was the fact that some dyers took advantage of using less good materials, which made the bad impression.

He would like, before he sat down, to say how very pleased he was that Professor Armstrong had taken the chair. From the first occasion when he had visited him, in 1915, Professor Armstrong had taken a profound interest in the development of

the work, and had been an enormous stimulus to the young chemists of the firm. He would ask one or two of them out to lunch in order to talk over things, and one could hardly realise how much that helped in the early stages of the work. He could not be too grateful for the very keen interest which Professor Armstrong had always taken in the matter, and he desired to close by asking the audience to pass a hearty vote of thanks to Professor Armstrong for presiding.

The vote of thanks was carried unanimously, and the meeting terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 15..Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Informal Meeting.
At the University, Liverpool. 7 p.m. Annual General Meeting.
At the University, Edmund Street, Birmingham 7 p.m. The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages."
Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m.

TUESDAY, APRIL 16..East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Colonel Sir T. Carey Evans, "Health Progress in India."
Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Prof. C. Bresciani-Turroni, "The Movement of Wages in Germany during the Depreciation of the Mark and after Stabilisation (1920-28)."
Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. R. Bell, "Transport Developments in 1928."
At the Queen's Hotel, Birmingham. 6 p.m. Annual General Meeting.

WEDNESDAY, APRIL 17..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. E. T. Painton, "Problems involved in the Design of Overland Transmission Lines."
Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as Applied to Steam Generation."
At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Annual General Meeting.
Food Education Society, 29, Gordon Square, W.C. 3 p.m. Mr. C. E. Hecht, "Aids to Fitness."
Metals, Institute of, at Thomas' Café, Swansea. 7 p.m. Annual General Meeting.
Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. The late W. H. Dines and L. H. G. Dines, "Monthly mean values of Radiation from various parts of the Sky at Benson, Oxfordshire" (Vol. 2, No. 11). 2. Mr. L. H. G. Dines, "An Analysis of the Changes of Temperature with Height in the Stratosphere over the British Isles" (Vol. 2, No. 18). 3. Mr. H. A. Hunt, "A Basis for Seasonal Forecasting in Australia."
Microscopical Society, 20, Hanover Square, W. 7.30 p.m. 1. Professor Dr. E. Ghosh, "Two New Suctoria from Sewer Water." 2. Messrs. P. L. Li, H. S. D. Garven, and R. Howard Mole, "The Microscopic Anatomy of the Vascular System of the Dog's Spleen." 3. Mr. D. S. Spence, "A Method of Finding the Refractive Index of a Drop of Mounting Medium."
United Service Institution, Whitehall, S.W. 3.30 p.m. Lt.-Commdr. J. J. C. Irving, "Coronel and the Falklands."

THURSDAY, APRIL 18..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Colonel V. C. Richmond, "R101."
Antiquaries Society of, Burlington House, W. 5.30 p.m.
Automobile Engineers, Institution of, at the Technical Institute, Guildford. 7 p.m. Mr. H. W. Pitt, "Central Lubrication of Chassis Bearings."
Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. R. A. Chattock, "The Modern Use of Pulverised Fuel in Power Stations."
At Trinity College, Dublin. 7.45 p.m. Mr. J. D. Ferguson, "Electric Time Signalling."
Linnean Society, Burlington House, W. 5 p.m.
Mechanical Engineers, Institution of, at Halifax. 6.45 p.m. Mr. J. G. Stirk, "Modern Machine Tools."
Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

FRIDAY, APRIL 19..Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Lt.-Colonel J. T. C. Moore-Brabazon, "Early Aviation."
Dyers and Colourists, Society of, at Milton Hall, Manchester. 7.30 p.m. Annual Meeting.
London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. The Right Hon. Sir William Bull, "London and the Channel Tunnel."
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. W. Reavell, "Keys and Keyways."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Prof. P. W. Bridgman, "The Properties of the Elements under High Pressures." (Guthrie Lecture.)
Royal Institution, 21, Albemarle Street, W. 9 p.m. Professor Owen T. Jones, "The History of the Grand Canyon, Yellowstone National Park."

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FRIDAY, APRIL 19th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 22nd, at 8 p.m. (Aldred Lecture.) SIR E. DENISON ROSS C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic Movements in Asia." (Lecture I).

WEDNESDAY, APRIL 24th, at 8 p.m. (Ordinary Meeting.) LYNTON FLETCHER, B.A. (of the British Broadcasting Corporation), "Recent Developments in Educational Broadcasting." PROFESSOR T. PERCY NUNN, M.A., D.Sc., Litt.D., will preside.

COUNCIL.

A meeting of the Council was held on Monday, April 8th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Alexander Gibb, G.B.E., C.B.; Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir Henry A. Miers, F.R.S.; Sir Richard Redmayne, K.C.B.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society:—

Abbott, Stephen Shapland, Southall, Middlesex.
Ali, A. Yusuf, C.B.E., London.
Atkins, Henry Kent, London.
Bodley, Frederick Charles, Ontario, Canada.
Catchatoor, T. N. Joseph, Rangoon, Burma.
Cooper, Arthur Thomas, M.Inst.C.E., London.

Cramp, Charles Courtney, London.
Dart, Edward N., Pelham, New York, U.S.A.
Delfos, Cornelis Fredrik, Pretoria, South Africa.
Fielding, George William, Ashton-under-Lyne, Lancs.
Gibson, Norman R., Niagara Falls, New York, U.S.A.
Glass, Frederick James, Doncaster.
Godson, G. Bird, London.
Hashmi, M. Nasiruddin, Hyderabad, India.
Heasman, Arthur William, M.V.O., O.B.E., London.
Heylin, Henry Brougham, O.B.E., Tilehurst-on-Thames.
Jatia, Kanai Lall, Calcutta, India.
Lang, John G., Saltash, Cornwall.
McDougall, Charles, London.
McGowan, Sir Harry, K.B.E., London.
Olsen, George Frederic, Los Angeles, Cal., U.S.A.
Patrick, William Thomas, J.P., Guildford, Surrey.
Ramey, Blaine, B., Towson, Maryland, U.S.A.
Rau, Ramanathpur Subba, Bombay, India.
Reynolds, Lyn, Hyde, Cheshire.
Warburton, Percy, High Lane, Cheshire.
Watson, Alexander Silver Foord, Fallowfield, Manchester.
White, Thomas G., Seven Kings, Essex.

The thanks of the Council were accorded to Sir Charles Wakefield for his donation of £500 to the Fund for the Preservation of Ancient Cottages.

The Chairman of the Council and Mr. P. Morley Horder, Chairman of the Executive Committee of the Fund for the Preservation of Ancient Cottages, were authorised to sign the contract for the sale of West Wycombe and to affix the Society's seal thereto.

Further consideration was given to the question of the award of the Albert Medal for 1929.

Preparation of the Balloting List for the new Council was begun.

A quantity of financial and formal business was transacted.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 10th, 1929. SIR RICHARD A. S. PAGET in the Chair.

A Paper on "Some Modern Aspects of Electrical Communication," was read by MR. G. H. NASH, C.B.E., M.I.E.E., European Chief Engineer, International Standard Electric Corporation. The Paper and discussion will be published in the *Journal* on June 7th.

INDIAN SECTION.

FRIDAY, APRIL 12th, 1929. SIR STANLEY REED, K.B.E., LL.D., in the Chair. A paper on "Recent Electrical Developments in India," was read by MR. A. T. COOPER, M.Inst.C.E., M.I.Mech.E., M.I.E.E., M.Cons.E. The paper and discussion will be published in the *Journal* on June 14th.

PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 27TH, 1929.

DR. L. A. JORDAN, D.Sc., F.I.C. (Director, Research Association of British Paint, Colour and Varnish Manufacturers) in the Chair.

The following paper was read :—

EAST INDIAN COPALS AND DAMARS.

BY A. F. SUTER.

INTRODUCTION.

Resins are, with one important exception, of vegetable origin, formed by the oxidation of natural or artificially stimulated exudations from certain plants. The exception referred to is shellac, which, instead of exuding from the plant, has to pass through the body of an insect attached to the plant.

The *resins* are, therefore, closely allied to such botanical products as latices, vegetable waxes, gums and wood oil ; in fact, there are quite a number of intermediate products, containing two or more of these exudations in mixture. A very large number of plants of various natural orders produce resins. These differ in their characteristics comparatively little, but not all of them have attained economic value.

The *distribution* of resiniferous plants is world-wide, extending in both hemispheres from the equator far down into the temperate zones. Copals and damars are found right through the Far East in a broad belt along the equator and again through the African continent. In the southern hemisphere, New Zealand, between 40 and 50 degrees of latitude, is the home of the Kauri resin, and similar copals occur in Northern South America, Brazil and along the Andes to points much further south. In the northern hemisphere, resins are collected largely round the Mediterranean and Central Europe, while the pine forests of North America are responsible for enormous quantities of oleo-resins.

As I have stated, not all of these resins are collected and employed in industry. Of those known to commerce, the two chief groups are the *copals* and the *damars*. The resinous products of the various pines are grouped by themselves, since they mostly do not come into commerce in their raw state, but are distilled into spirit of turpentine and rosin at the source of production. Among the *minor resins* are best known sandarac from Morocco and Southern Australia ; mastic from Chios and the Levant generally ; red and yellow accroydes from Southern Australia, and benzoin from the East and West Indies.

The grouping of the major resins into copal on the one hand and damar on the other, is somewhat arbitrary but quite useful, being based upon the difference of their physical characteristics. It is with these two groups that we shall chiefly concern ourselves to-night.

The copals of commerce comprise the following resins, given with their botanical origin and chief country of collection :—

Macassar, or Manilla Copal	*Agathis alba Foxw.*	Dutch East Indies.
Kauri Copal.	*Agathis robusta.*	New Zealand.
Congo Copal.	*Copaifera* and *Trachylobium spp.*	Belgian Congo.
Zanzibar or Lindi Copal.	*Trach. Horni-manniana.*	Zanzibar, Madagascar and East Coast.
Mozambique or Inhambane C.	*Copaifera* species.	Madagascar and East Coast.
Sierra Leone Copal.	*Copaifera Guibourtiana*	West Coast Africa.
Angola (Benguela) Copal	*Daniellia* species.	West Coast Africa.
Demerara Copal.	*Hymenea Courbaril* (Locust tree).	West Indies and Central America.

Of these resiniferous trees, the *Agathis alba* and *A. robusta* belong to the order of the Coniferae, all others to the order Leguminosae, sub-order Ceasalpiniaceae.

The damar-producing trees all belong, as far as is known, to the rich and varied natural order of the Dipterocarpaceae, chiefly the genera *Shorea, Hopea, Balanocarpus, Vatica* and *Vateria.* They are all indigenous to the tropical belt from Ceylon eastward to New Guinea and are collected very largely in Sumatra, Borneo and the F.M.S.

I may mention to you now that the name copal, which is Mexican for resin, is unknown to the natives in the East. Both groups, damar and copal, are called damar, the Malay name for resin or a torch made of resin.

In Europe, commercially, the true description resin is seldom applied to these substances ; they are erroneously called gums, on account of their physical similarity to the true gums.

COPALS.

Of the various copals known to commerce, the one to concern us to-night is the *Macassar or Manilla Copal.*

This type of copal has its origin in one single plant, the *Agathis alba Foxw.*, and it occurs most frequently in the Dutch East Indies ; in Celebes, the Moluccas, Borneo, Sumatra and New Guinea. The tree also occurs largely in the Philippines, where it is exploited and in the Malay Peninsula, where the resin is, however, not collected. The tree does not exist in Ceylon or British East India, nor further west in the same latitudes.

The tree is, in the wider sense, a member of the Conifera, and is grouped with the Auracarias, of which family all of us know at least one member, the monkey puzzle. And really this curious tree is not unlike to the *Agathis alba*. I will show you a few pictures of a row of these trees which stand in the grounds of the Forestry Department in Buitenzorg, Java. These are about 25 years old and probably about 50 to 70 feet high. On the other hand, in the virgin forests of Central Celebes, I have seen many specimens of about 200 feet high and said to be probably over 500 years old. Those of you who have seen the flag staff in Kew Gardens may obtain a good idea of the height of a full-grown copal tree, since this mast (the bole of a Douglas fir) is just about 200 feet high.

The *Agathis alba* does not favour ground near the seashore, but prefers altitudes from 1,000 ft. upwards, and flourishes well at much higher altitudes. You must, however, not imagine forests of copal trees as we have forests of pines or spruce or other conifers in Europe or America. These trees occur singly or in small clumps, very often barely 100 to the square mile and at times as few as a dozen. In the thick tangle of the undergrowth, and the generality of the forest being somewhere between 60 and 100 ft. high, the *Agathis* trees

*A row of young *Agathis Alba* at Buitenzorg in Java.
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are not easily to be seen from below. If, however, you stand on a height, overlooking a large stretch of forest, the closely woven canopy is dotted all over with the *Agathis* crowns which stick out far above the general level. As you have seen, these cylindrical crowns are easily recognisable at a distance. The forests are so dense that, in order to visit the trees, you have to follow perforce the paths made by the copal tappers or hack your way through the tangle of tropical growth.

**Agathis Alba*, 180ft. high in Malili district.

For the description of the tree, after seeing the pictures, it will suffice to say that the bole or trunk is perfectly round and nearly the same thickness all the way up, very straight and usually provided with branches only on the upper third. The bark is quite smooth and of an impressive greyish brown tint, much like the plantain trees one sees so often in English towns. This similarity goes further still in so far as the copal tree bark also renews itself in more or less round flakes or whirls, showing at first a beautiful brick-red below.

The tree is bi-sexual, carrying both male and female flowers, the male being small catkins. The fruit is a flattish cone, bright green until maturity

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in two years. The seeds are placed each in the centre of a fly-leaf for distribution purposes. The leaves are in appearance greyish and of a leathery texture, much like the leaves of mistletoe. The branches, being placed nearly vertically, give the crown its conical shape. It is only at very high altitudes that the crowns appear somewhat flatter. The root system consists of an enormous tap root with a ring of wide-spreading surface roots. The system is almost always completely buried, and I have in no case seen buttress roots as are so common with damar trees.

In comparison with the Kauri pine in New Zealand, the *Agathis alba* is in no way behind as far as height is concerned, but in point of circumference or diameter, the Kauri pine is said to be three times the size. Yet the *Agathis alba* is probably one of the biggest timber trees of the Indies. If it be possible to judge the age of a tree by its year-rings, then the biggest Kauri pine has been found to be 2,400 years old; while the *Agathis* forests of Malili in Celebes show no trees older than 500 years. The growth of these trees is by no means as rapid as one might be led to believe by their size; in this respect the *Agathis* is comparable to *Tectona grandis*, the teak tree, the timber of which is known to all of you. Although not of the value of teak, the *Agathis* timber is also employed for many purposes locally. It is perhaps unfortunate that a tree which yields such a valuable forest product, should at the same time be a valuable timber tree, but you will find the same combination applying to the damar trees.

The Resin. Copal is a natural exudation from the bark of the *Agathis alba* at places where the latter has been injured, by accident or design. It has been definitely found that resinosis, that is, the process of the production and exudation of the resin, takes place only in the bark. When a piece of bark is removed from the trunk, innumerable tiny drops of a sticky liquid begin to exude at once. In colour these are very pale, some clear and some opaque. In a few days they have grown to long streaks down and below the area from which the bark has been removed, and have hardened on contact with the air to such an extent that they can be removed quite easily. This polymerisation to a hard substance naturally chokes the wound and stops the flow, but when the resin is removed and the wound scraped afresh, the flow starts again.

What purpose the resin fulfills in the process of vegetation seems something of a mystery still. It has been argued one way and the other by the botanists, and purposes have been ascribed to it of which I believe it is quite innocent; personally I find it difficult to change my opinion that the sole purpose of the resin is one of protection against damage of any kind, in which case it would be of pathogenetic origin.

Foxworthy distinctly states that "occasionally pieces of wood very densely impregnated with resin are found, these being nearly always small, very heavy and very dark in colour." Van de Koppel, on the other hand, asserts that

during the whole of his stay in the copal forests of Malili he had never found any resin ducts in the wood, either sap or heart. I mention this because, the resin never being found in the normal process of vegetation, it is specially manufactured in times of need, *i.e.*, protection to the tree. It may be as likely, therefore, to occur in the sapwood immediately below the cambium as in the inner bark, provided the damage to the tree has been sufficiently deep to provoke this pathogenetic process.

Tapping Methods. Before I enter upon a full description of the present day methods of exploitation and cropping of copal, I ought to give you an idea of the various kinds of copal of the Macassar type known in trade. They are :—

*Bole showing correct tapping.

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(*a*) Hard or fossil copal, of unknown but often very great age, and very hard.
(*b*) Half-hard copal, less hard and much younger.
(*c*) Soft or spirit-soluble copal.

Type *a* is found either in the crotches of branches in old trees or else dug from the ground at the foot of old trees or where trees at one time existed. Types *b* and *c* are of recent origin and are obtained by the removal of portions of the bark from living trees.

In the forests of Malili, where the tapping of copal trees has now been practised as a well-regulated industry for years, the method of tapping the trees has become very uniform, owing to strict supervision by forestry officials. These foresters have to enforce the stringent rules and regulations in order to prevent the heavy over-tapping which took place in earlier years and was the direct reason for the extensive mortality among the trees.

In Malili there are reckoned to be about 200,000 copal trees spread over perhaps 2,500 square miles, and leased for exploitation to about 1,500 natives. The trees are leased by the Government to the natives in batches of 50 to 200. The native undertakes to tap the trees according to the regulations in force, any serious transgression or the death of trees through over-tapping being punished by forfeiture of the lease or even imprisonment.

In this district, the tapping is done in the following way: a horizontal cut is made with a heavy knife through the bark to the wood of 15 to 30 cm. length, and the bark is removed in the form of an apron below this cut. The exudation from the cut flows over the wood and, therefore, remains clean. The wound is renewed in an upward direction about one month after the first tapping. The fresh exudation trickles over the first accumulation and hardens into a big lump of copal. One month later the third enlargement of the wound takes place to re-start the flow. At the end of three months the accumulation of copal is removed from the tree, broken up and carried away by the tapper. This product, therefore, consists of a mixture of copals, some three months, some two months and some one month old. It has been found in practice that copal exposed to the atmosphere on the tree for more than one month loses its alcohol solubility completely, so that this accumulation consists of somewhat under one-third of spirit soluble or soft copal, and the rest of half-hard copal. It demands an exceedingly practised hand to distinguish the two kinds from one another, when it comes to sorting the copal, and those of you who manipulate these two kinds in practice will readily recognise in this method the origin of some of your troubles.

I have samples here of exudations of one day; one, two and three weeks; and one, two and three months old. In solubility, they behave as they would be expected to, except the one-day-old stuff, which is perfectly soluble, but fails completely as regards viscosity, giving a solution as thin as if turpentine had been added to the alcohol.

Now it must not be supposed that the considerate method of tapping as described above has always been in use by the natives. It will astonish most of you to hear that extensive tapping of living copal trees did not become a common practice in Celebes until about 1916, although it was known and, to some extent, used, on some of the Moluccan islands, particularly Batjan, Ternate and Great Obi. Once the native discovered that the exudation had commercial value and could easily be sold to traders in the coast settlements, he quite naturally set to work with a very heavy hand. The more wounds he cut into a tree, the more copal exuded, at least for a time. The results of such excessive tapping are most horrible to behold; to a man who loves trees, the sight is as pitiful as that of deformed or crippled humanity.

*Incorrect tapping, showing many badly healed wounds.

Thousands of trees became hollow, died and snapped off, a yard or so above the ground. About 1918 the first steps to check this terrible waste were taken by the Central Government in Java, strict tapping regulations being issued through the headmen, but it was found impossible to impose

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observance of these regulations and restrictions by the natives until five or six years later, when a forestry official was stationed in the Malili district, who was given the means to enforce the regulations.

But even today, in the light of what has gone before, it is difficult to say what is wise and what is overtapping. Trees occasionally still die off; whether as a direct result of the tap wounds or not, cannot be determined yet. Two points, however, have been settled; one, that the least possible area of bark should be removed from the tree, and, two, that the total length of the horizontal cuts must not exceed one-half of the circumference of the tree. The Government regulations prohibit the tapping of trees of a girth less than 1.50 m. in Celebes and 1.75 m. in the Moluccas. Nor must the tapping be carried higher than 2.50 m. from the ground.

Yield of Trees. Up to recent years very erroneous opinions of the yield of the copal trees existed. These were based probably on native statements, which notoriously tend to exaggeration. Since, in Malili, trees are now farmed out in definite numbers of 50, 100, and 200 to each tapper, much more reliable figures have been obtained lately, but even here very large variations have been observed, namely, between 8 and 40 picols per 100 trees per annum. The highest yields have been shown in the area between the Matano and Towoeti lakes, by trees with a very large diameter and growing in very rich soil. The lowest yields are given by trees in very arid soil and of smaller diameter. Van de Koppel gives the figures of 12 kg. per tree as an average in the Malili district.

Collection and Transport. You must remember that before about 1916 tapped copal was unknown in Celebes; the only copal gathered by the natives was the fossil kind, dug from the ground, or the white boea, found in much smaller quantities in the crowns of the trees. Generally speaking, as long as the varnish maker was the only consumer, the demand was not sufficient to encourage the natives to any systematic search. Later, when the values increased through a fuller application in new industries, it was soon found that the stores in the earth were not inexhaustible. Also, experienced climbers were not always at hand to fetch the fine white lumps occasionally visible in the crowns from a height of 100 to 150 feet. Not all natives care for climbing. In this way hard copal became scarcer and dearer. Macassar still exports both grades, but in small quantities as compared with a decade ago.

To-day, with the tapping of copal established as an industry, conditions have naturally changed. It has been found that certain tribes, sometimes not even of the district, take more kindly to tapping than others. They are employed for this purpose by the leaseholders who are resident. Other tribes, of a more wandering disposition, make excellent carriers and are, therefore, entrusted with the transport of the copal from the seat of production to the nearest marketing place. But, strange to say, in Celebes there are large numbers of pack horses in existence and they are extensively employed

in the transport. In the Malili district, round the two big lakes, the copal is taken to the nearest shore station on one of the lakes and from there by canoe as far as possible; then by land transport again to the port. The journeys from the centre of production to the coast port may take up to a week. From here the coastwise traffic picks up the material and delivers it to the buyer in Macassar, who may be a European firm or a Chinese or an Arab.

*Copal carriers in Celebes.

Although much of the copal is partly or wholly graded in Malili, and may actually be exported from there, the major portion of the supplies find their way to the copal traders in Macassar, no matter whether they come from the Malili district or the Toradja country or the surrounding islands. By this time the copal has passed through probably four different hands.

You must remember that, although the supervision of the forestry department has a powerful effect upon the industry, this is in the first instance directed towards the protection of the trees; the standardisation of the product is a contributory but secondary consideration. The product remains a forest product; therefore, in point of quality, not comparable to a definite culture, such as rubber or tea.

The ultimate exporter in Macassar comes into possession of the copal in various ways. He may have a note from a Chinese dealer to say that sample bags of a new arrival were being shown at these stores; would he come and inspect them? The exporter will do so and leave with the Chinese a bid for the lot in a sealed envelope. Such inscription sales are very frequent, at least once a fortnight, and for lots varying from a few cwts. to several tons. Or the exporter may send his own buyer up to Malili or Polewali or Mamoedjoe to buy the copal on the spot and send it down direct to him by

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steamer. Another and less natural method of trade has sprung up during the years of high prices, a system of cash advances by the exporting house to the chiefs of certain districts. By this means the quantity of copal certainly increased largely, but the quality gradually suffered badly, and in the end the exporting houses who started this method had to write off very large losses.

Preparation and Sorting. We have seen that the supplies of copal are received at the centre of ultimate export in a very mixed condition. Not only are soft and half hard grades always caked together into a block, but at times there are also found in the block pieces of fossil copal which have accidentally been found in the forest. It is, therefore, necessary to separate the various grades.

*Copal grading at Macassar.

The block is smashed first of all with a wooden mallet into smaller pieces, and disintegrates along the lines of adherence between harder and softer pieces. The palm leaves which have served as packing are removed. Around a large heap of this material in the godown (a corruption of the Malay word "goedang" meaning a shed) are squatted the sorters. These are mostly always women, native or Chinese, and of all ages. The mothers have their babies with them and children begin sorting as soon as they can sit still. I have seen establishments of this sort of over 100 women and girls, with as many children round about them, all happily chatting and chanting while sorting copal with astonishing swiftness.

Some of the women crush the pieces of copal into smaller fragments and pass them on to their neighbours. The latter have four or five baskets in front of them, filling each one with a separate grade or size of the fragment. When full, the baskets are emptied into large storage bins.

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Four fundamental considerations have to be observed in the grading of copal; firstly, hardness; secondly, colour; thirdly, purity (absence of extraneous impurities); and fourthly, size. Machinery is never employed, native labour being plentiful and cheap. But the latter has one disadvantage. It is exceedingly difficult to induce any of the sorters to change their method, their movements becoming completely automatic once they think they have understood the meaning of the work. The children are taught sorting not so much by the overseer as by their mothers. Very early they detach their mental processes from the work in hand, being swift enough with their fingers, but miles away in mind. This fact may explain the apparent excess of labour expended on this operation. I have observed that a greatly superior number of grades is sorted by the women than ultimately appears in the European markets. These grades are later re-incorporated into a certain definite number of standard grades and then packed in cases, baskets, or bags for export.

Certain regulations regarding the health of the sorters are in operation in Celebes, pulmonary diseases produced by the prevalence of fine dust being feared. Often the women powder themselves thickly with rice powder to prevent the copal dust entering the pores of the skin and spoiling their complexion.

The *hard* copals, Malay name Boea, are sorted according to their size into five grades from A to E, although various colour standards are also in existence. The preparation for export in their case simply consists in removing the weathered crust by a sharp knife.

The *half hard* copal, Malay name Loba, is also assorted into five grades, A to E, according to size, but variations in colour are responsible for a number more.

The *soft* copals, Malay name Melengket, are sorted in the first instance according to their purity, as they usually contain more or less wood, bark or other impurities. The assortment originally was:—

No. 1. Free from wood.
2. Very moderate amount of wood.
3. Fair amount of wood.

But the distinction between the three grades was never sharp enough. Nowadays each shipper runs his own marks and tries to maintain these standards both as regards colour and purity.

Use of Copals in Modern Industry. Copals were up to a recent period exclusively employed for the manufacture of varnishes. The soft copals, being completely or nearly completely soluble in cold alcohol, are employed for the making of spirit varnishes without further preparation. The hard and half-hard copals require to be heat-treated, that is, melted and cooked for some time before they become soluble in drying oils.

Kauri copal finds extensive employment in the manufacture of linoleum,

at least the inferior grades, but it is the half-hard Macassar copals which have come into very large demand during the last decade. On account of their thermoplastic character, they are used for all sorts of pressed and stamped articles in the form of a binder; very often in conjunction with or instead of shellac, with which they share several physical properties. Their di-electric properties, however, are much inferior to those of shellac.

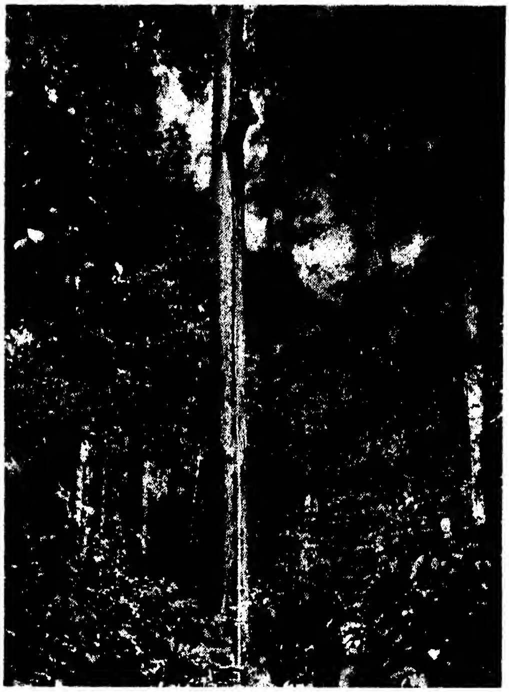
Synthetic products of a character similar to resins are now coming into vogue and it looks as if these forest products were losing favour in some directions, but I believe that, given accurate standardisation of the product, they will be capable of withstanding such competition. However, this is the age of the chemist, so that many of the raw products of nature will depreciate in value in proportion to the usefulness of a synthetic competitor.

Damar Resins.

Many more kinds of damar are known to exist than ultimately come into commerce, but they all are the product of one plant family, the *Dipterocarpaceae*. This family is of enormous importance in the tropical forests of the East Indies and, in parts of its range, notably Sumatra and Malaya, it accounts for perhaps more than a third of the existing trees.

The *Dipterocarpaceae* comprise a number of members, and these in their turn, a considerable number of species. Speaking of Malayan forests, Mr. Foxworthy has described five species of *Balanocarpus;* 15 species of *Dipterocarpus;* 11 species of *Hopea;* 21 species of *Shorea:* 16 species of *Vatica*, and so on. Now the predominant value of these trees, which are chiefly very large and belong to what is called the first or top storey of the tropical forest, lies in their timber, for which they have hitherto been more exploited than for their resinous exudations. For a long time the resin has been regarded as a secondary and often negligible product, except perhaps in Sumatra. It strikes me as curious that the Forestry Department of the Dutch East Indies should have directed its attention almost exclusively to the collection of copal from the *agathis alba*, it being well known that the commercial varieties of damar suffered from botanical impurity, that is, not coming from one tree species alone.

We have to thank the Forestry Department of the Federated Malay States for the first move in the correction of this defect. Some years back it was decided to keep scrupulously apart the resin from one specie of *Balanocarpus*, to grade it into the usual commercial varieties and to test the various markets with the material. This experiment has now grown into a production of about 100 tons per annum and, I believe, has fully justified itself. Some of you present may know the damar, although we in London have never seen much of it so far. I am speaking of damar *Penak*, the product of *Balanocarpus Heimii.*



**Balanocarpus Heimii* bole; damar being gathered by native.

By far the largest proportion of damar in commerce comes from Sumatra. A very large percentage of the total area of the island is covered with rain forests, and these contain, as I have stated, very many damar trees. Next in importance, at least as far as collection is concerned, comes the Malay Peninsula, including that portion of Siam which is situated on the Peninsula. The forests in Borneo are capable of producing large quantities of damar, but the collection is not so well organised, except in the district of Pontianac, on the West Coast. Java, with her dense population and very high state of cultivation, has little room for primary forests, although Batavia has always been known as the chief grading and distributing port of the finer kinds of damar. In Celebes damar certainly exists in good qualities, but the collection is in its infancy. Ceylon shows no damar exports, although most of the species mentioned are indigenous there. The Moluccas and New Guinea will in time probably add greatly to the world's production.

The methods of tapping damar trees differ largely from those of the *Agathis alba*. You will remember that the copal tappers do not wound the trees higher than a man can reach from the ground, by one cut extending horizontally from one-third to one-half of the circumference, removing the bark below. The damar tapper, on the other hand, appears to make a great many small

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wounds at intervals right up the trunk to the crown. He makes a transverse cut with his parang and then extends the wound upwards notchwise, actually forming a pocket in the trunk. Unlike copal, the fluid damar oozes out of this wound very slowly and in much smaller quantities, forming small nodules, tears and stalactites. The exudations are collected about three months later and the wounds are re-opened. The trunks are invariably too thick for a man to climb unaided. The native, therefore, sets about constructing a ladder by hammering into the trunk small pegs of hard wood or bamboo every two or three feet up the trunk. To these pegs he attaches a length of rattan and his ladder is complete.

Except under Forestry Department supervision in Malaya, damars are usually collected by the native forest population, people of extremely primitive and wild habits still, especially in the more central portions of the islands. Together with other forest products the collected damar is carried down to the nearest village or coast town, if near to the sea, where it passes into the hands of Arabs or Chinese in barter. They sell it to native merchants or to the depots of European firms, by whom the material is shipped to the port, at which it is sorted. Damars from the west coast of Sumatra are usually shipped from the ports of Sibolga, Padang and Benkoelen to Batavia. The East Coast, however, ships most of the material via Belawan, Bengkalis and Palembang to Singapore, this port being nearer. As to Borneo, Pontianac supplies also go mostly to Singapore, but Bandjermasin in the south supplies Batavia. Damars collected in the Malay Peninsula naturally find their way to Singapore, as do those from Sarawak and British North Borneo.

Sorting and Grading. In commerce the view used to be prevalent that there were three different types of damar, and that, in point of quality, they were firstly Batavian, secondly Singapore and thirdly Padang. There is no doubt that the Batavian type, being graded more correctly, had this to recommend it, but to-day we know that all three types are practically identical, seeing that by far the largest supplies originate in Sumatra. Batavia grades the raw material into five different grades, according to size, from A to E, A being the largest particles and E nearly dust. Singapore and Padang grade into three different sorts, according to colour, impurities and, to some extent, also size. The sorting is done by Chinese or Arabs in all three ports, native female labour being employed just as in Macassar. The sorter sells to the shipper at the port, who forwards the material to the usual ports in Europe and America.

Types of damars. Where you have such a vast number of trees supplying the resin, some confusion as to the botanical origin of each type must naturally exist, the collection taking place by natives exclusively. Damar exists in a range of colours from nearly pure white through the whole spectrum to blue-black, both clear and opaque. In size, the small nodules, tears and stalactites of the well-known sorts contrast strongly with that of the inferior

grades, which may occur in very large stalactites or very large lumps similar to fossil copal. It is by no means certain that these larger masses of damar are fossil, although some of them undoubtedly are. In the centre of Java I have been told there exists a hill wholly composed of fossil damar in the form of a nearly solid rock, covered with no more than about one foot of earth on an average. A few tons which have been mined lately are now coming to London for investigation.

Those types which are regularly absorbed by commerce are :—

(*a*) Mata Kuching, the finest white damar, from *Hopea intermedia*. Siam supplies the whitest and boldest. In Malaya the tree is said to die on tapping. Comparatively speaking, only small quantities come into trade, most of the supplies being incorporated into the three following sorts.

(*b*) Batavian, Singapore and Padang sorts, mostly of Sumatran origin, and being obtained from species of *Hopea*, *Shorea* and *Isoptera*, all closely related to *Mata Kuching*.

(*c*) Penak damar, collected botanically pure in the F.M.S. from *Balanocarpus Heimii* King and graded in a special way.

(*d*) Rasak damar, of a bright yellow colour, often opaque, graded A to E, considerably harder than the former three types. From genus Vatica.

(*e*) Hiroe damar, also bright yellow, from *Vatica* species, from Sumatra, Borneo and the Moluccas.

(*f*) Damar batu, stone or fossil damar. This is a collective name for a number of inferior grades of various colours and origin, especially Shorea spp.

(*g*) Damar Hitam or black damar, from *Shorea* species, often containing canarium resin and frequently mixed in fossil and recent form.

Of late years, (*e*), (*f*) and (*g*) have also been sorted into five grades, A to E, and they all appear to serve distinct purposes in varnish making.

Use in Modern Industry. Unlike copal, damar has not found any use beyond for varnish making, for which latter, however, it is a very valuable resin. Being completely soluble in cold spirits of turpentine, it produces with little manipulation a highly lustrous varnish, applied largely for coating paper and general use indoors. The darker and harder damars find employment according to their physical properties in varnishes for various purposes. It also finds application in the Batik Cotton dyeing industry.

Generally speaking, the paler the damar, the softer it is. Mata Kuching, Penak and the Batavian, Singapore and Padang sorts are now employed for incorporation into cellulose varnishes. They all contain a small percentage of harder resin than the bulk, which can be precipitated from the toluol solution by the addition of alcohol. This small portion is erroneously called wax, and we hear nowadays of such atrocities as " de-waxed damars." The harder damars are quite unsuitable for this purpose.

TOTAL FROM ALL DUTCH EAST INDIAN PORTS DURING 1926.

	Damar.	Copal.
	10,202	15,350
SINGAPORE, ABOUT		
	8,500	1,760

Of the damar exported from Singapore about 2,000 tons are collected in Malay Peninsula, the bulk of 6,500 tons coming to the port from Sumatra and other islands.

Although I do not possess the actual figures for 1928, I can tell you that the exports of copal have increased considerably, whilst damar exports are equally considerably back. It also appears that Macassar is still growing in importance as the premier port of Copal exports, chiefly at the expense of Singapore.

Of these exports, both in copal and damar, the U.S.A. take roughly two-thirds or more. Germany consumes far more damars of all grades than England, but the latter imports much larger quantities of copal.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said it was quite clear that the lecturer had discovered the key of romance in business. One thing which had interested him (the Chairman) was the question of labour in the East. His own experience only went as far as India—and he did not know whether Mr. Suter would count that as being east at all! The labour question was always a trial in those places. It was evidently a great trial in Malaya. In the part of India with which he himself had been associated they had had to employ the women in order to obtain their husbands; and in order to obtain the women they had also to take the children, too. The result was that in even a small establishment there might be as many as 200 or 300 women, and the work done might be singularly small for such a big crowd. All sorts of interesting complications arose therefrom. For instance, at one place he had in mind there were two Lancashire boilers, one of which was in use, the other being kept as a standby. When the time came round to change over from one boiler to another for cleaning out purposes, the first thing which had to be done was to pick out all the babies which had been parked in the tubes of the spare boiler, needless to say, in defiance of all rules.

The lecturer had mentioned the Dutch official aspect of things, and he would be much interested to know whether he had seen that famous agricultural and general experimental station which the Dutch had in Java. One heard many remarkable things about it. There was one extraordinary thing about the Dutch as colonists; they were extremely diligent and they made a very good job. Probably a part of the reason of that was because they had such a small corner of the tropical earth in which to do everything, and consequently there was a very heavy concentration of what was the best of the Dutch culture, and of all those other excellent qualities which went to make successful colonisation. Probably, also, that was the reason at the back of the rather disturbing fact that Singapore was losing its position to the Dutch port of Macassar.

Being a curious person, he had to confess that he was rather anxious to know more, if possible, about why a tree made resin. The lecturer had stated that the various authorities said there were no resin ducts in the wood, and suggested that the origin was pathogenic. If it was so, the tree got into action remarkably quickly after being damaged. He was not a botanist, and therefore perhaps it was highly dangerous ground for him to tread upon, but he thought it was generally agreed that much more had yet to be learned about the normal and abnormal processes of tree secretions and growth. There were certain trees which secreted abnormal products in the bark, and it had been suggested that in those cases the secretion was probably functioning as a filter to protect the inner structure of the tree from the high concentration of ultra-violet rays in the very fierce sun of the East.

As a chemist he ought not to conclude without referring to the development of the chemistry of the resins. The lecturer had expressed a righteous indignation at the use of the term a "de-waxed" damar. It was fairly clear now that the "wax" was highly polymerised resin and that its presence was also linked with the general problem as to how these gums changed in the early stages of their life, and during the period of running in solution. Problems of polymerisation entered into many matters concerning resins, and it was quite likely that sooner or later X-ray methods of investigation might give some sort of explanation.

MR. T. HEDLEY BARRY said it was very appropriate that the lecture should come at the time of the British Industries Fair, where manufacturers gathered together and generally overhauled their consciences and considered the ways in which they could improve themselves. A great deal had been heard during the last week about the importance of manufacturers knowing their materials, and knowing what was wanted. The lecturer was a very interesting and valuable example of a manufacturer who had got to know his materials and what was wanted.

With regard to the resins themselves, the problem was a very fascinating and a very perplexing, and very often rather a disheartening one. The point which was of most interest was the difficulty of collection, the extreme difficulty of sorting, and then the difficulty of getting the material to the right people in the right way. With regard to one small area to which the lecturer had referred, namely, Malaya, he remembered that when he had made his own first report to the Chief Forester, he had referred to the great difficulty of forging a close link between the home market and the forester. Although the technical service was excellent, the connection between the field of operations and London was extremely defective. He was very glad to learn that the lecturer had been able to add something to the link between this country and the Malayan forester.

With regard to the future of resins, synthetic resins had been mentioned. He noticed that every gum merchant referred to synthetic resin, and there was a feeling that the natural resins were up against a competition which might affect them seriously. It was not enough to collect the material; it was not enough even to get it over here. There must be a continuous and progressive policy of research on the subject for the future good of the industry. Otherwise some outside product would come in and cut it out. One could take a natural resin and, by chemically treating it, obtain a product which was more uniform, and which did away with some of the present excessive grading. This excessive grading, entailing the material passing through an enormous number of intermediate hands between the final buyer abroad and the tree itself, was one of the great troubles in connection with the industry. The most successful synthetic resins at present were blends of natural

and synthetic resins, and that suggested that chemical research on resins might lead to their becoming ingredients of another article.

Mr. Noel Heaton stated that the lecturer had devoted practically the whole of his life to the study of resins, and the Society that night had before it absolutely first-hand information about the origin and collection of resins. To have such first-hand information was of the greatest interest and importance, because in the past writers and others who had been trying to find out something about the origin of resins, and so forth, had been obliged in general to rely upon second-hand information. All resins were collected in far-away districts in the East, and in the past those interested in the subject had had to rely for their information on two sources—either residents in the country, who knew a lot about the country and the method of collection but who knew very little about resins, or people who knew a lot about resins but who had never been out to the East. That night, however, the audience had had the advantage of hearing an expert in resins who had gone out to study the matter at close quarters and who had brought the information on the matter very much up-to-date.

One point of difficulty was that of nomenclature. In the past different gums had been grouped under the same name, with the result that there had been a good deal of confusion. For instance, only last week he had been discussing the subject of varnishes with an American friend, who had told him that in the manufacture of a certain type of enamel he used East India gum. He had asked his friend: "What do you mean by that?" and he had received the reply: "We just know it in the States as East India gum." That was the sort of thing that went on all over the industry. The term "copal" was very vaguely used. It was a great pity, too, that the term "copal" had been applied to the resin from Macassar—the so-called manilla copal. As he understood it from the description of the lecturer, that resin was obtained from quite a different genus of tree from the East and West African copals which were derived from the Copaifera trees. It was quite a different type of resin, and it created a great deal of confusion having these entirely different materials referred to under the same name.

The lecturer had stated that under the new Government regulations in regard to collecting copal it was laid down that a tree must not be tapped above a height of 2½ metres. Personally, he was not quite clear as to the technical reason for that. In the case of damar he gathered that the natives went quite a considerable way up the tree to tap, and that the higher they went the better quality of resin they obtained. It would be interesting to know what essential difference there was between the two types of tree which necessitated the different methods of collecting the resin. He would also like to know what was the life of a tree when it was properly tapped. The lecturer had clearly shown that improper tapping very quickly led to the death of a tree, but it would be interesting to know how long one was able to tap a tree in a properly scientific manner and still keep it alive able to deliver its quota of resin. Also, in that connection, what steps were taken, if any, in most districts to provide for the replacing of trees that were lost? Was there any systematic method of re-planting the trees?

On the subject of synthetic resins, one point he would like to make was that, whilst there were many varieties of synthetic resins, not one of them was really a synthetic resin. What he meant was as follows: When one spoke of synthetic indigo one meant the actual chemical substance which was present in the indigo produced by entirely artificial means. When one spoke of a synthetic ruby one meant the actual chemical substance—crystalline corundum—formed by artificial means. But when to-day one spoke of synthetic resin, one meant a material

which had something of the properties of resin but which was an entirely different chemical substance. It was simply a synthetic resin in the sense that it resembled it in some of its physical properties. As far as he was aware, no one had really made a synthetic resin in the same way that the tree made it. That was the point he was driving at, and possibly the lecturer would state if any investigations had been made on that point.

MR. J. CRUICKSHANK SMITH said that one point which had struck him in hearing the first part of the lecture had been the application of the word "copal." He endorsed what Mr. Noel Heaton had said in regard to the very misleading significance which the word "copal" conveyed to anyone in the industry. As he understood it, the lecturer had dealt with what were known in the trade as the soft or spirit-soluble copals only, and even in those materials there was found an extraordinary difference in physical properties. He desired to ask the lecturer to give some indication as to the probable life of the trees which produced those soft copals. It would appear, in view of the rather primitive methods of tapping, collecting, and so forth, and also in view of commercial contingencies, market prices and the like, that the position of the manufacturer who wanted to use those resins from year to year was not a very pleasant one. Owing to the likelihood of the supply running out, and apparently for other reasons, there was a strong presumption in his own mind that the day might come when there would be no more of those so-called soft copals available. That time was foreshadowed by those who were talking of synthetic productions. Again, the word "synthetic" was used in an extraordinarily loose sense. Unless they could get down to some physical comparison between the so-called synthetic re-productions and the natural products, the unfortunate manufacturer would be no better off than he was before. With regard to the damars, the same line of argument applied. The Batavian, Sumatra and Penang damars could all be distinguished in terms of physical properties, and when that was done a step forward would be taken in getting better and more uniform conditions in the manufacturing world.

MR. H. W. MORGAN said the lecturer had given all those interested in the industry something to digest. The lecture would be a standard reference for them for a very long time to come. They had heard that night what they had never known before. He desired to thank Mr. Suter for his extremely interesting and valuable lecture.

MR. ARTHUR T. EVANS asked the lecturer to give some further information about the origin of that hill of fossil damar in Java—what its area was, and what the yield was per ton. It was an extraordinary thing to have happened.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., said the lecturer had spoken about the harbour of Macassar, but had not given any idea as to its depth, or as to whether it was a tidal harbour.

MR. SUTER said it was an open sea harbour and could accommodate ships up to 10,000 tons gross.

SIR ARTHUR CLARKE said Mr. Suter had mentioned the fact of nothing having been done to develop the resin industry in Ceylon. What was the reason ?

MR. SUTER said he had seen the Chief Forester, who had told him that he was very much afraid that they at the Forestry Department had become nothing but

timber merchants to the Government. Anything in the nature of minor forest products they had no time for. The natives in Ceylon did not use the resins which were indigenous to the country, and therefore they were never produced except on demand ; and there was no demand for them because it took a long time to get the natives to tap in a proper way.

SIR ARTHUR CLARKE then said that the lecturer had thrown on the screen a picture of a wonderful tree of great height with a native climbing up it, and had remarked that he would not like himself to ascend it. It would not have troubled him (Sir Arthur) in the least degree to have gone up that tree. If the audience could see a small boy up the skysail yard arm of a ship, lying over on her beam ends, in a squall, trying to furl the sail, they would think nothing at all of a native climbing the tree which had been shown.

MR. SUTER, in reply, said the Chairman had asked him to say something with regard to the Central Government in Java and their influence on cultivation in the Dutch East Indies. It was very difficult indeed not to be too enthusiastic when speaking of that matter. There was some quality about the administration in the Dutch East Indies that was most admirable. He believed at the bottom of it all lay the fact that the Dutch were most systematic people. Whenever they found anything new they gave it to the scientists for full examination and investigation. They educated their people in the applied sciences necessary to cultivation in the tropics to a most extraordinary degree. They got hold of the very best men ; nationality meant nothing to them. They would not support any old-fashioned machinery.

The whole of their attention was directed towards the production of these valuable copal trees. Nobody knew how long a tree would live under the present system of tapping, but the Dutch were carefully studying that matter. Copal would never die out. The Dutch had found it to be a valuable product from a fiscal point of view. They had found the necessary labour for it, and they had the necessary scientists to produce a really good article.

Mr. Heaton had mentioned the question of nomenclature. The Americans called it East India gum. That meant Macassar gum. The description of Macassar copal was very much better than manilla copal. What came out of the Philippines to-day in the shape of copal was a very inferior spirit soluble copal. This product went to America, but it was too dear owing to labour costs, and was gradually disappearing against the very much finer produce which came from Macassar. Macassar undoubtedly was the one port where all the good East Indian copals went to-day. There were not sufficient trees in Malaya to make a systematic collection, and another very grave difficulty in Malaya was that the resin would not harden. The same thing happened in Sumatra. Therefore it was no use from a commercial point of view. Mr. Heaton had asked, Why limit the height of the copal tapping ? That was done because the Dutch said : " We will not kill our trees. We will give you less copal now, until we know how far we can go." As to what was the life of a tree with proper tapping, that was not known. With regard to the re-planting of trees, that matter was also in the hands of the Chief Forester.

Mr. Cruickshank Smith was under a slight misapprehension in thinking that he had only dealt with the spirit-solubles. He had only dealt with the Macassar copals. They comprised three—hard, half-hard and soft. A fact which had not been known before was that the soft and the half-hard were an identical product, with merely a slight difference in age.

He had not been able to see the hill of fossil Damar at Java. It was said to consist of literally thousands of tons of resin. A few tons were coming across now, and it would then be seen of what the resin was made. As to how that great quantity of resin got concentrated in that particular locality, it could only have got there through an earthquake destroying the forest above it.

CAPTAIN SIR ARTHUR CLARKE said it was his pleasure and duty, on behalf of the Council of the Royal Society of Arts, to thank the lecturer very cordially for his very interesting and most instructive lecture. He had listened to a great many lectures before the Society, but he had never yet heard a lecturer who had so fully grasped the *raison d'être* of all the various questions, and who had answered them so clearly as Mr. Suter. He only hoped that that wonderful hill in Java full of copal would come to fruition some day !

The vote of thanks was carried unanimously, and the meeting terminated.

CORRESPONDENCE.

RATIONAL MECHANICS.

Your reviewer admits that " the basis of Academic Mechanics is not always as sound as it might be and there is much in current text-books that may be usefully criticised." To this I cordially agree, since it is my point. At the same time, he considers me as one of those awful heretics who dares to question the dicta of the " High Priests of Mechanics " (I trust that he will do me the justice to admit that I do not attack any small men), and consequently (I can only suppose) thoroughly deserving of " something with boiling oil." I must therefore thank him for having treated me with such leniency.

He suggests that I do not " understand the subject." This may, as it may not, be true ; but as I have specialised on mechanics—chiefly hydromechanics—for exactly forty years, at least I think I can say that I have tried my best ! *Rational Mechanics* was commenced more than ten years ago, and it has been written six times, so it has not been published in a hurry. I think I have read most of the books and papers dealing with the subject, written in English, French, Italian and Spanish, so I cannot be accused of being narrow-minded.

Unlike most, your reviewer does not confine himself to meaningless " generalities," such as saying that my views are "unsound," etc., etc. He puts his finger down, and says, " *this* is wrong "—for which I thank him ; I am grateful.

The first point he specially refers to is my criticism of Glazebrook's equation " $U = Fs$," which, he says, we learn " is equating scalars and vectors."

Well ! is it not ? Work is a scalar quantity, whilst force and space are vectors. Is this disputed ?

But, he says later, that I " do not appear to have met with vectorial multiplication." As a matter of fact, I have ; and I *thought* I had even mentioned that $A \times B$ is not the same as $B \times A$. The reviewer's suggestion (if I understand him correctly) is that vectors multiplied together produce a scalar. That I have *not* " met with." I have learned that they form a " quaternion "—which is essentially a vector quantity. If preferred, however, I will modify my statement and say that Glazebrook here " equates a scalar and a quaternion."

I am also reproved for saying that this paragraph is meaningless. I thought that this was fairly evident, but let me cross my " t's " and dot my " i's " a little more carefully.

Glazebrook says, page 93, " force as a *cause of motion* we have not here to consider ; it will suffice for us to define it as *rate of change of momentum*." This is splendid ; it is Glazebrook at his best !

Substituting the words, the paragraph at page 118 reads : " let the point of application of the *rate of change of momentum* be displaced, etc." How does one *displace* a rate of change of momentum ? What sort of *idea* do these words convey ? Also, on page 119, we read (changing the words, as before) : " Find the *rate of change of momentum* exerted, etc." How does one " exert " a rate of change of momentum ?

I should like to say a good deal more, but space forbids, so I can only refer to one more point. Your reviewer says that I consider that Poisson's description of the behaviour of a liquid is to be taken " as a literal fact." I certainly *do.* I think also that if the reviewer would study Theodore Schwedoff's *Recherches Expérimentales sur la cohésion des Liquides*, in the Société Française de Physique for 1889, he would see experimental proof of what I have said. It certainly satisfied me, and it is, in any case, *extraordinarily interesting.*

Finally, if mechanics is to be anything more than a mathematical plaything, it should enable us to calculate the resistance of bodies moving in fluids. Now, what can the academic mechanics enable us to calculate ? One can only sadly reply, " nothing." Lamb's monumental work explains very fully what " perfect " —? mathematically-trained—fluids would do. *Real* fluids, however, are ferae naturae, and do not behave "as they ought to." Following Newton's teaching—Newton, that intellectual " wonder of humanity "—I have shown that it is not difficult to calculate these resistances ; and I suppose that what one fool can do, another can.

R. DE VILLAMIL.

NOTES ON BOOKS.

FRENCH SIXTEENTH CENTURY PRINTING. By A. F. Johnson. London : Ernest Benn, Ltd. 15s.

This book traces the development of what may be termed the renaissance style in French printing from its birth under the influence of Italy in the early 16th century, up to the effective entrance of engraving upon the field of book-decoration about 1596.

The sixteenth century is seen to open with types of the Gothic order in full and vigorous possession of French typography. Up to 1500 the humanist influence of Italy had as yet scarcely been felt in France, and it was not until the Italian classical revival had captured first the imagination of such scholars as, for instance, Robert Estienne and Geofroy Tory, and inspired them with the idea of becoming, as publishers and printers, the typographical god-parents of the new learning, that the roman and italic types commenced their vogue as the natural interpreters of its spirit.

Once started, the progress was rapid, nor was it confined to printing alone, in the sense of the utilisation, in book-design, of existing types. The art of type-design and type-cutting in France also took fresh force with its new direction. At first the French craftsmen frankly drew for their inspiration direct upon Italian work such as the *Polifilo* and the Aldine classics, but it was not for long. The French genius quickly produced original models, showing, it is true, a natural kinship with

the Italian, but yet definitely native and significant. Here rise the "Garamond" romans of Colines and Estienne, of Augereau, and of Claude Garamont himself, while there is an equal, and fully as interesting, parallel development of the cursive types, ranging from the more formal and monumental "faces" such as those of Colines and Denys Janot to the more delicate and condensed Aldine character.

Though it is true that, in individual hands and in a limited channel, the Gothic did actually survive until the close of the century, it may be said to have passed out of general use by 1530.

The middle of the century finds the purely native romans of the so-called Garamond genus widely and securely established; to such a degree, indeed, that they remained in full use into the opening of the 18th century both in France, the Netherlands and elsewhere, and were destined to dominate the roman letter in France for an even longer period.

The influence of great men is always difficult to determine, since they are in general too fully occupied in the living of life and the fulfilment of the bent of their genius to be narrowly concerned in leaving memorials, signed, dated and authenticated, behind them. Nor, perhaps (at least to the general reader), is exactitude in this direction of great importance, though it certainly gives difficulty to the historian of printing.

Mr. Johnson necessarily, however, surveys briefly the many-facetted work of Geofroy Tory, to whom, under the dual spell of ignorance and enthusiasm, there has been a tendency to attribute a disproportionate share of the work of this very active period. Tory—scholar, publisher, artist and *homme d'esprit* as he surely was—did not himself print much, and it is perhaps to his stimulating influence upon the work of others, both printers and type-designers, together with his initiation of the lighter form of book decoration, designed to harmonise in "colour" with the new types it accompanied, that one must look for his greatest, if least definitely mensurable, contribution to his time.

That the name of Claude Garamond (or Garamont as he seems to have styled himself) has come to be applied to many of the roman founts of his period is not perhaps unnatural, upon the results of a first and cursory investigation, but the light of more recent critical research (see Mr. Johnson's work in *The Fleuron*, Vol. VI) has shown that much of such attribution (at least in the direct sense) is unfounded. As Mr. Stanley Morison has remarked, it is somewhat of an irony that, of the many modern "Garamond" revivals, the one which approaches nearest to the spirit of Garamont's great letter is the only one *not* called by his name. This is the "Granjon" of the Linotype Company.

Robert Granjon is a name which, with Jean de Tournes, stands for the greatest force in the Lyonnese typography of the period under review. Hitherto it has been Paris that has been tacitly referred to, but the significance of Lyons was, in its own field, fully as great, and especially in the French development of the Italic. The influence of the Lyons printers passed, as did Granjon's types and "fleurons," far beyond the borders of France, modifying and deeply affecting the work of the Netherlands and England also.

In matters of decoration, the work of Tory has already been touched upon. The light-coloured, graceful and "lively" arabesques associated with his name and with those of Tournes and others, and the combinable "flowers" of Granjon, expressing their motives in black upon an open ground, were in natural harmony both with the colour-weight of the new faces, roman and italic, and with the free spirit of the renaissance of which they were the outcome. Hence their displacement of the heavier, black-grounded or *criblé* decoration, characteristic of and natural to the strong, austere gothic pages, was inevitable and immediate. The 17th century

ushers in a new and significant development in French book-decoration—the use of engraved work upon title pages, and in initials and page-embellishments. At this point Mr. Johnson fittingly closes his essay.

The publishers rightly style this work an essay rather than a book. The scope is wide, the treatment discursive, yet lucid, giving in its skilful handling no obtrusive sense of the wide knowledge and the labour upon which it is based. It seems calculated rather to stimulate interest and give direction to further and more detailed study of the subject than to provide detail though, in reality, much detail is there. In this connection, a bibliography, however slight, would have been a welcome addition, since the opportunities for first-hand research amongst originals are denied to the majority of readers.

The 50 plates cover a wide range, but it is difficult to see why they must be placed at the end of the book, divorced, not only from the relevant passages in the text, but even, by the method of arrangement, from their own descriptive matter. In fact, the suggestion is hard to avoid that the plates were chosen not so much to illustrate the essay as for each to stand alone ; the two linked more by a somewhat cool, sisterly affection, bordering on mutual indifference, rather than by any close conjugal bond. This would seem borne out by the fact that the text makes but three specific references to the plates and, of these, one is incorrect.

No book whose subject is typographical can fail itself to be examined from the typographical point of view, however illogical it may be to do so. It would seem part of the eternal fitness of things that books upon matters of printing should be produced in a manner at least decent, typographically speaking. In this and in respect of its paper, Mr. Johnson's very pleasant volume is unfortunate. It is printed upon a Matt "Art" paper, of all papers the least defensible ; nor can it be pleaded that this is technically unavoidable, for "line" reproductions such as are here presented can (as has been amply demonstrated) be printed readily upon "Antique" papers. Compare, for example, that fifth number of *The Fleuron* to which Mr. Johnson refers on p.18. In the present instance, not only does the "Art" paper lend a mean and characterless appearance to the pages, while it robs the volume of durability, but it emphasises the unhappy selection of the type used. Caslon "Old Face" is never a strong type and is at its best without space between the lines. When, as in this book, it is used in Pica size, "leaded" to allow the eye to "carry" so wide a line, and is, in addition, very loose-set, the effect becomes acutely miserable. Mr. Johnson's skill and labour, alike, are worthy of a better setting.

D.W.L.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock.

April 24.—Lynton Fletcher, B.A. (of the British Broadcasting Corporation), "Recent Developments in Educational Broadcasting." Professor T. Percy Nunn, M.A., D.Sc., Litt.D., will preside.

May 1.—P. Morley Horder, F.S.A., "Architectural Models." The Right Hon. Lord Askwith, K.C.B., K.C., D.C.L., will preside.

May 8.—Charles J. ffoulkes, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts." Professor W. Rothenstein, M.A., Principal, Royal College of Art, will preside.

May 15.—Robert Burrell, Barrister-at-Law, "The Reform of the British Patent System."

Indian Section.

Friday afternoons, at 4.30 o'clock.

May 10.—P. Johnston-Saint, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.) Sir E. Denison Ross, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, will preside.

The lecture will be illustrated by lantern slides.

Aldred Lectures.

Monday evenings, at 8 o'clock.

Sir E. Denison Ross, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic movements in Asia." Four Lectures: April 22, 29, and May 6, 13.

Lecture I.—The Arabs. The Arabian Peninsula. Life in town and desert. Primitive religion of the Arabs. The rise of the Prophet Muhammad. Dissension and warfare among the Arabs. Unification of the Arabs. Advance of Arab arms into Syria and Persia. Triumph of Muslim armies East, North, and West.

Lecture II.—The Turks. The Mongolian desert. The rise of the Turks. The Great Wall of China. The first Westward movement of the Turks.

Lecture III.—The Seljuks. The infiltration of the Turks into Transoxania and Khurasan. The rise of independent Turks in Islam. Mahmud of Ghazna. The rise of the Seljuks.

Lecture IV.—The Mongols. The rise of Chingiz Khan. His career of conquest. The invasion of Europe by the Mongols. The invasion of Persia by Hulagu Khan. The sack of Baghdad.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, April 22..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Mr. John Begg, "The Work of George Wittet."

Asiatic Society, at the Royal Society of Arts, Adelphi, W.C. 5 p.m. Dr. W. Filchner, "My Central Asian Expedition, 1925-1928." (Joint Meeting with the Central Asian Society.)

Automobile Engineers, Institution of, at the University, Sheffield. 7 p.m. Dr. H. J. Gough, "Recent Developments in the Study of the Fatigue of Materials."

Geographical Society, at the Polytechnic Theatre, Regent Street, W. 8.30 p.m. Mr. G. M. Dyott, "The Search for Colonel Fawcett."

At Lowther Lodge, Kensington Gore, S.W. 4 p.m. Miss E. G. R. Taylor, "Roger Barlow: An Early XVIth Century Geographer."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Annual Meeting. Informal Discussion on "The Engineer as a Salesman."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. Alfred Schofield, "Humanity."

Tuesday, April 23..Automobile Engineers, Institution of, at the Engineering and Scientific Club, Wolverhampton. 7.30 p.m. Mr. H. W. Pitt, "Central Lubrication of Chassis Bearings."

Chadwick Public Lecture, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8 p.m. Mr. C. E. Stromeyer, "What Health and Civilization owe to Engineering."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Wednesday, April 24..British Science Guild, at the Mansion House, E.C. 4.30 p.m. (1) Sir Frederick Keeble, "Fertilisers from the Air. (2) Mr. A. B. Shearer, Rayon "(Artificial Silk)." (3) Mr. F. H. Carr, "Synthetic Drugs."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m.

Eugenics Society, at Burlington House, W. 5.15 p.m. Dr. C. J. Bond, "Hemilateral Asymmetry in Animals and Man and its Relation to Cross-Breeding."

Geological Society, Burlington House, W. 5.30 p.m. "The Geology of part of North-Western Rhodesia," by R. Murray-Hughes, with Petrographical Notes by A. A. Fitch."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Thursday, April 25..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Squadron-Leader C. L. Scott, "By Flying-Boat to India."

Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Sir Harold Hartley, The Theodore W. Richards Memorial Lecture.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Dr. G. C. Simpson, "Lightning." (Kelvin Lecture.)

University of London, at Bedford College for Women, Regent's Park, N.W. 3 p.m. Prof. Mackie, "The Study of Scottish History."

Friday, April 26..Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. W. Holmes, "Load-levelling Relays and their Application in connection with Future Metering Problems."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Discussion on the teaching of Geometrical Optics. Papers by Mr. T. Smith, Dr. G. F. C. Searle, Instructor-Captain T. Y. Baker, Dr. J. W. French, Mr. W. Ewart Williams, Mr. C. G. Vernon, Mr. H. H. Emsley, Mr. C. W. Hansel, Mr. H. Tunley, Mr. L. Moore, Mr. Conrad Beck, My V. T. Saunders, and Dr. C. V. Drysdale.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. R. W. Chambers, "English Civilisation from Alfred to Harold, 900-1066."